

Albian microbiostratigraphy ( foraminifera  
and Ostracoda ) of S.E. England and  
adjacent areas.

VOLUME 1.

by

Colin Stuart Harris B.Sc.,M.Sc.

Thesis submitted for the Degree of  
Doctor of Philosophy to the Council  
for the National Academic Awards.

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DECLARATION

This is to certify that the work submitted for the Degree of Doctor of Philosophy under the title "Albian microbiostratigraphy ( foraminifera and Ostracoda ) of S.E.England and adjacent areas" is the result of original work.

All authors and works consulted are fully acknowledged. No part of this work has been accepted in substance for any other degrees and is not being concurrently submitted in candidature for any other degree.

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## ABSTRACT

C.S.Harris      Albian microbiostratigraphy ( foraminifera and Ostracoda )  
of S.E. England and adjacent areas.

The microfauna ( foraminifera and Ostracoda ) of the Albian Stage has been thoroughly documented by previous authors and many zonal schemes have been proposed. While these schemes have been defined on very thorough research, the majority have been defined on one fossil group, and occasionally on one genus or several genera. This project attempts to refine the existing zonation based on foraminifera, to correlate it with the existing Ammonite zonal scheme, and propose a detailed zonation based on Ostracoda which have been integrated with both the zonal schemes mentioned above. To achieve this, the stratigraphically most continuous sections were examined.

A total of 18,990 planktonic foraminifera (6 species), 71,800 benthonic foraminifera (56 species) and 48,440 Ostracoda (99 species) were examined from 20 localities. Several genera were studied extensively to illustrate the 'evolution' of populations during Albian time and to attempt to ascertain the palaeoenvironmental conditions. These studies showed that distinct morphological trends occurred and that these changes (mainly in size) are directly related to changes in the environment. Major changes in the planktonic population and in the morphology of the genus Hedbergella have been used to define a number of Biohorizons in the Middle and Upper Albian. These Biohorizons represent marked changes in the palaeoenvironment and generally coincide with the macrofaunal zonal boundaries. The morphological changes of the benthonic populations can be shown to be directly related to these Biohorizons. The changes in the planktonic and benthonic populations have been interpreted as indicative of a gradual deepening of the Albian Sea while the Biohorizons reflect both the changes in depth and in surface water temperature of the Albian Sea.

The definition of the multi-phyletic zonal scheme was mainly based on the stratigraphic position of these Biohorizons and on the first appearance of benthonic foraminifera and Ostracoda. The zonal schemes were defined on information from the Glyndebourne (I.G.S.) borehole and the Folkestone sections. This zonal scheme was then applied to the M.25, Upper Greensand and southern North Sea Basin sections. Several of the problems in Upper Albian stratigraphy were resolved. The major changes in the fauna have been shown to be related to changes in the environment, these environmental changes also resulted in lithological changes. Thus, the major lithological changes, and the large stratigraphic breaks, can be related to the Biohorizons.

## INTRODUCTION

The stratigraphic potential of micropalaeontology has been recognised since the last century. Over the last sixty years it has proved a valuable tool for the applied geologist, and recently it has become increasingly important in resolving stratigraphic problems. The massive expansion of applied geology, in, and around the United Kingdom over the last two decades (associated with oil exploration), has resulted in a large amount of raw data, some of which is now available for stratigraphic research.

The Albian Stage has been researched very extensively by sedimentologists, stratigraphers, and palaeontologists and the Albian microfauna has been thoroughly documented during the last century. However, it is only recently that the stratigraphic potential of Albian microfossils has truly been recognised (Carter & Hart, 1977; Price, 1977b). Previously, the study of foraminifera has dominated Albian microbiostratigraphy and little research has been undertaken into the stratigraphic potential of other microfossil groups. The biostratigraphy of Ostracoda in the Albian has received very limited attention and only Neale (1978) has defined a realistic zonal scheme.

Many zonal schemes have been based on the Foraminifera and these have culminated in the proposal of zonal schemes for the Aube (Magniez-Jannin, 1975), for northwestern Europe (Price, 1977b), and for southern England (Carter & Hart, 1977). The contradictory nature of all these recent schemes indicates that, especially in the uppermost Albian, many problems, both stratigraphic and taxonomic, still remain. The present study is an attempt to resolve some of these problems related to the foraminiferal biostratigraphy and to define a complementary zonal scheme based on Ostracoda.

During the course of this study it has become apparent that the bulk population changed drastically during the Albian and that several

faunal provinces existed. Correlation between these is extremely difficult and can only be achieved by the utilisation of all the available information. This provincialism, although distinct in the Albian, is much less apparent in the Upper Cretaceous; this has clearly been illustrated by Bailey (1978, MS.) and Swiecicki (1980, MS.), whose zonal schemes appear to be applicable over much of the north-western European continental shelf.

This study has used a large amount of information on Albian stratigraphy and much of this has been summarised in the following chapter. The works of Casey (1961) and Owen (1971a, 1975) are clearly of fundamental importance in any proposed zonation of the Albian Stage. The information from these publications was augmented by a large amount of unpublished macrofaunal information which was kindly provided by Dr. H. Owen (British Museum; Natural History) and Dr. A. Mörter (Institute of Geological Sciences).

In order to analyse the Albian Stage in southern England, six major, and two minor sections have been examined. These were compared with two sections collected from Germany, two from France, and five from the southern North Sea Basin. This resulted in the examination of nearly 500 samples for both foraminifera and Ostracoda. A total of 61 species of foraminifera and 99 species of Ostracoda have been described, of these, 48 species of foraminifera and 60 species of Ostracoda were used in the definition of the proposed zonal scheme.

## CHAPTER ONE

### HISTORY OF PREVIOUS RESEARCH

During the last one hundred and fifty years, Albian biostratigraphy has been discussed in great detail by a large number of authors. These works have indicated the complexity of Albian stratigraphy and, therefore, the present study can only be regarded as another small step in the search for a more complete understanding of this subject.

#### 1:1 Stratigraphy

The Albian Stage was first proposed by d'Orbigny (1842) for the interval between the Aptian and the Cenomanian. The name was derived from the Roman name for the Aube (Alba) district of France. Included in the original list of localities were Folkestone, Kent and Wissant, northwest France.

In England, the Albian has been divided into three Substages and these have been divided into Zones and Subzones based on *Ammonoidea*. This was achieved by the publication of a number of zonal schemes (Casey, 1961; Owen, 1971a and 1975), which were compared by Price (1977b) to those from France and Germany. Price then summarised this information and suggested a modified zonal scheme, which divided the Albian Stage into seven Zones and twenty three Subzones and was entirely based on *Ammonoidea* (fig.1:1).

For many years the study of the British Albian was involved in the problem of the relative position of the major sedimentary facies. Jukes-Browne & Hill (1900) showed that the Lower Greensand was stratigraphically older than the Gault Clay and that the 'Glaucconitic Marl' was a separate lithological unit. They also considered the Red Chalk to be a distinct lithological unit. Subsequently, these facies have been recorded from much of northwestern Europe. Prior to

Fig. 1:1 The ammonite zonation of northwest Europe ( after Casey, 1961; Owen, 1971a; b ;1975; adapted by Price, 1977b ).

|               |  |   |
|---------------|--|---|
| UPPER ALBIAN  | <u>Stoliczkaia dispar</u>                      | ? no macrofaunal equivalent<br><u>Mortoniceras (Durnovarites)</u><br><u>perinflatum</u>   |
|               | <u>Mortoniceras (M.)</u><br><u>inflatum</u>    | <u>Mortoniceras (M.) rostratum</u><br><u>Callihoplites auritus</u><br><u>Hysterocheras varicosum</u><br><u>Hysterocheras orbigny</u><br><u>Diploceras cristatum</u>   |
|               | <u>Euhoplites</u><br><u>lautus</u>             | <u>Anahoplites daviesi</u><br><u>Euhoplites nitidus</u>   |
|               | <u>Euhoplites</u><br><u>loricatus</u>          | <u>Euhoplites meandrinus</u><br><u>Mojsisovicsia subdelaruei</u><br><u>Dimorphoplites niobe</u><br><u>Anahoplites intermedius</u>   |
| MIDDLE ALBIAN | <u>Hoplites (H.)</u><br><u>dentatus</u>        | <u>Hoplites (Hoplites) spathi</u><br><u>Lyelloceras lyelli</u><br><u>Hoplites (Isohoplites) eodentatus</u>  |
|               | <u>Douvilleiceras</u><br><u>mammillatum</u>    | <u>Protohoplites (Hemisonneratia)</u><br><u>puzosianus</u><br><u>Otohoplites raulinianus</u><br><u>Cleoniceras (Cleoniceras) floridum</u><br><u>Sonneratia kitchini</u><br><u>Leymeriella (L.) regularis</u><br><u>Leymeriella acuticostata</u><br><u>Proleymeriella schrammeni</u> |
| LOWER ALBIAN  | <u>Leymeriella (L.)</u><br><u>tardefurcata</u> |   |



this work Lamplugh (1896) had studied the lithology of the Speeton Series, Red Chalk, and Carstone. These early workers also realised that the major lithological units may be diachronous and that it was the study of this topic which is fundamental to the understanding of Albian stratigraphy. This study has been greatly aided by refinements in Albian biostratigraphy which have resulted in the clarification of the stratigraphic position of the major facies and of the major time gaps. However, many unsolved problems still remain.

Until the last decade, major works on Albian biostratigraphy had been limited to the study of Ammonoidea. Spath (1923-1943), produced the first comprehensive work on British Albian Ammonoidea and Breistoffer (1947) discussed both the English and the French Albian Ammonoidea. Casey (1961) published a detailed account of the British Lower Greensand and proposed a zonal scheme based on Ammonoidea. Owen (1971a, 1975) described many sections of Gault Clay in the Anglo-Paris Basin and proposed a modified zonation for the Middle and Upper Albian based on Ammonoidea. Much of the biostratigraphic information for the 'Boreal Realm' was summarised by Van Hinte (1976), who compared it to a zonation of the 'Tethyan Realm'. This scheme and those mentioned above are compared on fig. 1:2 which illustrates the complexity of Albian biostratigraphy and the lack of a zonal scheme which can be consistently applied across much of northwest Europe.

The ammonite zonation has been used to correlate the Upper Greensand of southwest England and the Gaize of northwest France with the Gault Clay succession of the Anglo-Paris Basin. Hancock (1969) discussed the transgression of the Cretaceous sea in southwest England while Kennedy (1970) discussed the Albian and Cenomanian of southwest England. Both Juignet (1971) and Destombes et.al. (1977) discussed the French equivalent of the Upper Greensand in northwest France.

| SUBSTAGE                           | VAN HINTE (1976)<br>Boreal and tethyan<br>Pelagic Macrofossil<br>Zones |   | CASEY (1961), OWEN (1971a, b; 1975)<br>Hopliteid faunal province<br>(adapted by Price, 1977b) |  | PRICE<br>(1874)  | KHAN<br>(1952)   | WALTERS<br>(1958)                           | HART<br>(1973a)                     | PRICE<br>(1977b) | BERTRAM<br>&<br>KEMPER   | NEALE<br>(1978)                           | BIOHORIZONS                          | ZONAL<br>SCHEME |           |   |  |   |                  |     |
|------------------------------------|--|---|---|--|--|--|---|-------------------------------------|------------------|--|---|--------------------------------------|-----------------|-----------|---|--|---|------------------|-----|
| UPPER<br>ALBIAN                    | <u>Stoliczkaia</u><br><u>dispar</u>                                    | <u>Stoliczkaia</u><br><u>dispar</u>                           | ? NO MACROFAUNAL EQUIVALENT   | XIII   |  |  |   | 6a                                  | 9 i-iii          | <u>steghausi</u><br>&<br><u>bemerodensis</u>   | <u>Mandocytthere</u><br><u>harrisiana</u> | 8<br>7<br>6<br>5<br>4<br>3<br>2<br>1 | Fiii            |           |   |  |   |                  |     |
|                                    |  |   | <u>Mortonicer</u><br>( <u>Durnovarites</u> )<br><u>perinflatum</u>                            |  |  |  |   | 6(ii)                               | 8                |  |   |                                      | Fii             |           |   |  |   |                  |     |
|                                    |  |   | <u>Mortonicer</u><br>( <u>Mortonicer</u> )<br><u>rostratum</u>                                |  |  |  |   | 6(i)                                | 7ii              |  |   |                                      | Fi              |           |   |  |   |                  |     |
|                                    | <u>Mortonicer</u><br><u>inflatum</u>                                   | <u>Mortonicer</u><br>( <u>Mortonicer</u> )<br><u>inflatum</u> | <u>Callihoplites</u><br><u>auritus</u>  | xii  |  |  |   | 5a                                  | 7i               | <u>hannoverana</u>   |   |                                      | Eii             |           |   |  |   |                  |     |
|                                    |  |   | <u>Hysteroceras</u><br><u>varicosum</u>   | XI   |  |  |   | VIII                                | 7i               |  |   |                                      | Ei              |           |   |  |   |                  |     |
|                                    |  |   | <u>Hysteroceras</u><br><u>orbignyi</u>  | X  |  |  |   | VII                                 | 5                |  |   |                                      | 6               | Diii      |   |  |   |                  |     |
|                                    | <u>Diploceras</u><br><u>cristatum</u>                                  |   | <u>Diploceras</u><br><u>cristatum</u>   | IX   |  |  |   | 4a                                  | 4i               | <u>lurmanna</u> & <u>ventrocostata</u><br><u>lurmanna</u> & <u>ventrocostata</u><br><u>senilis</u>   |   |                                      | Dii             |           |   |  |   |                  |     |
|                                    |  |   |   | VIII   |  |  |   | V                                   | 4                |  |   |                                      | 4               | Di        |   |  |   |                  |     |
|                                    | MIDDLE<br>ALBIAN   | <u>Hoplites</u><br><u>lautus</u>                              | <u>Hoplites</u><br><u>lautus</u>  | <u>Euhoplites</u><br><u>lautus</u>   |  |  |   | <u>Anahoplites</u> <u>daviesi</u>   | VII              | III  |   |                                      | IV              | 4         | 4 |  | <u>Mandocytthere</u><br><u>harrisiana</u> | 4<br>3<br>2<br>1 | Cii |
|                                    |  |   |   |  |  |  |   | <u>Euhoplites</u><br><u>nitidus</u> | VI               |  |   |                                      |                 |           |   |  |   |                  | III |
| <u>Hoplites</u><br><u>nitidus</u>  |  | <u>Hoplites</u><br><u>loricatus</u>                           | <u>Euhoplites</u><br><u>loricatus</u>   | <u>Euhoplites</u> <u>meandrinus</u><br><u>Mojsisovicsia</u> <u>subdelaruei</u><br><u>Mormonohoplites</u> <u>niche</u><br><u>Anahoplites</u> <u>intermedius</u> | IV<br>III<br>II  | II   | II  | 3(ii)                               | 3iv<br>3iii      |  |   | Bi                                   |                 |           |   |  |   |                  |     |
| <u>Hoplites</u><br><u>dentatus</u> |  | <u>Hoplites</u><br>( <u>Hoplites</u> )<br><u>dentatus</u>     | <u>Hoplites</u><br>( <u>Hoplites</u> )<br><u>spathi</u>                                       | <u>Lyelliceras</u><br><u>lyelli</u>  | I  |  |   | I                                   | I                |  |   |                                      | 3(i)            | 3ii<br>3i |   |  |   |                  | Ai  |
|                                    |  |   |   |  |  | <u>Hoplites</u><br>( <u>Isohoplites</u> )<br><u>eodentatus</u> |   |                                     |                  |  |   |                                      |                 |           |   |  |   |                  |     |
|                                    |  |   |   |  |  | <u>Douvilleiceras</u><br><u>mammillatum</u>                    | <u>Douvilleiceras</u><br><u>mammillatum</u> |                                     |                  | <u>Protohoplites</u> (H.) <u>puzosianus</u><br><u>Utanoplites</u> <u>raulinianus</u><br><u>Cleoniceras</u> (C.) <u>floridum</u><br><u>Sonneratia</u> <u>kitchini</u> |   |                                      |                 |           |   |  |   |                  |     |
| LOWER<br>ALBIAN                    |  | <u>Leymeriella</u><br><u>tardefurcata</u>                     | <u>Leymeriella</u><br>( <u>Leymeriella</u> )<br><u>tardefurcata</u>                           | <u>Leymeriella</u><br>( <u>Leymeriella</u> )<br><u>tardefurcata</u>  | <u>N.W.GERMANY</u> <u>S. ENGLAND</u><br><u>Leymeriella</u> (L.) <u>regularis</u><br><u>L.acuticostata</u> <u>H.milletioides</u><br><u>Proleymeriella</u> <u>franhamia</u><br><u>schrammeni</u> <u>franhamensis</u> |  |   |                                     |                  | 1  |   |                                      |                 |           |   |  |   |                  |     |

Fig. 1: 2 A comparison of the major zonal schemes proposed for northwestern Europe.

Fig. 1: 2 A comparison of the major zonal schemes proposed for northwestern Europe.

Several authors have concentrated entirely on the lithostratigraphy of the Albian. These include Rhys (1974), who reviewed the lithostratigraphy of the southern North Sea Basin and Wood and Smith (1978), who discussed the Red Chalk of Eastern England.

In his detailed account of Albian stratigraphy, Van Hinte (1976) concluded that the Albian Stage lasted from 108 to 100 Ma. This conclusion differed from that of Casey (1964) who postulated that the Albian Stage extended from 106 to 100 Ma, and from Rawson et.al. (1978), who suggested a date of 94+ Ma for the Albian/Cenomanian boundary.

Finally, Rawson et.al. (1978) have reviewed much of the existing knowledge on British Albian macrobiostratigraphy and have compared the dating of many of the major Albian sections.

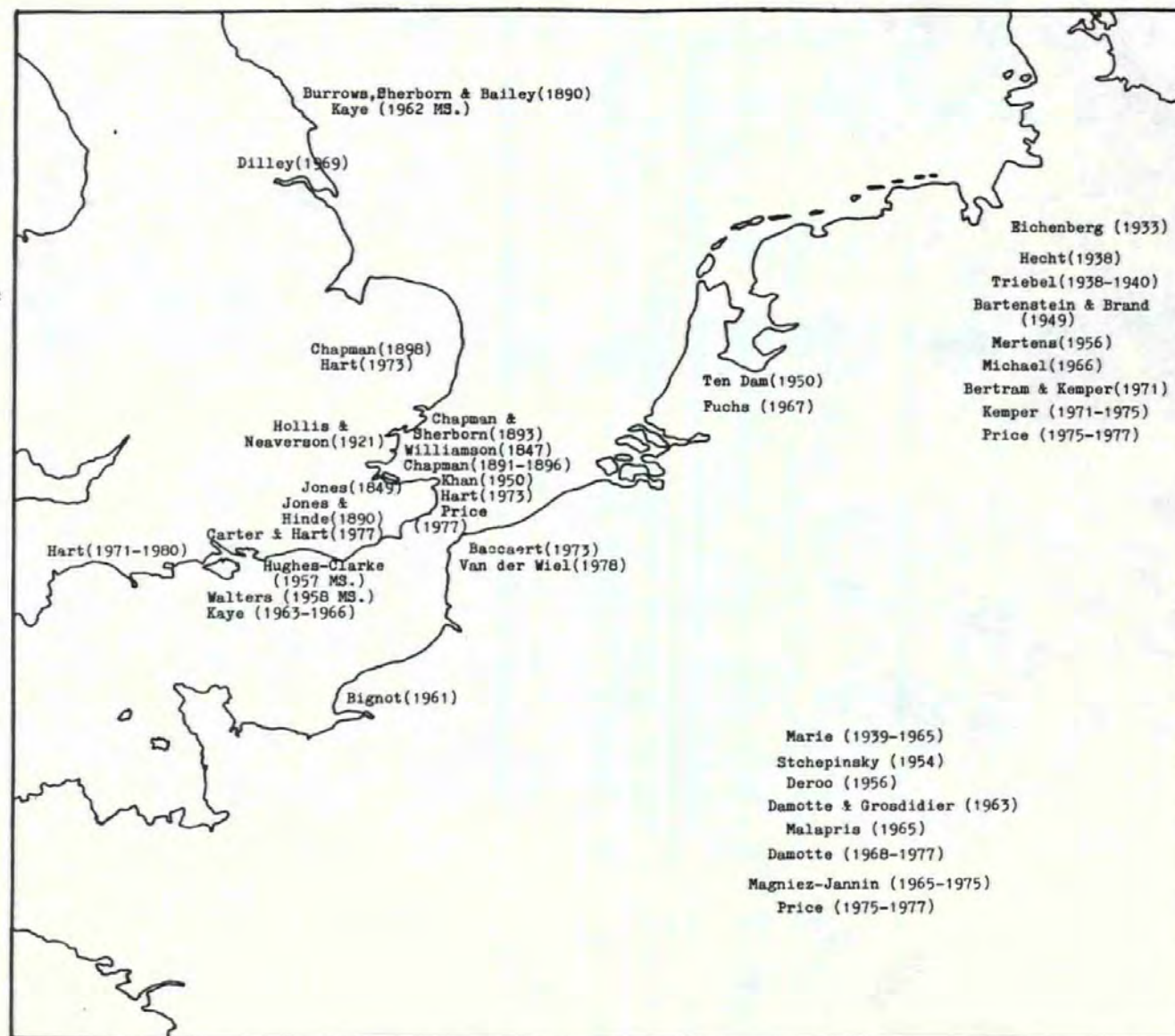
## 1:2 Micropalaeontology

During the last two decades the study of Albian microbiostratigraphy has advanced greatly with the publication of many detailed accounts on the taxonomy and biostratigraphy of both foraminifera and Ostracoda. The localities of these works and that of the major early works are summarised on fig. 1:3, which indicates that the majority of research has been centred on southern England, especially the localities in Kent, Sussex and Surrey.

### Foraminifera

During the last century publications on this subject were dominated by four people. These authors described the majority of Albian species. In France, d'Orbigny (1840, 1852) and Berthelin (1880) studied the Gault Clay fauna while Reuss (1845-1863) in Germany, and Chapman (1891-1898) in England, catalogued many of the important Albian stratigraphic markers. Chapman also provided very precise stratigraphic ranges for his species and both Berthelin and

Fig. 1: 3 An outline map of northwestern Europe showing the geographical distribution of some of the major works.



Chapman provided excellent illustrations with their descriptions of species. Two minor nineteenth century publications by Burrows, Sherborn & Bailey (1890) and Chapman (1898) listed species from the Red Chalk and Cambridge Greensand respectively.

The next contribution was by Hollis & Neaverson (1921), who listed the foraminifera from Ford, Buckinghamshire. This minor publication was followed by a series of major German publications (Eichenberg, 1933; Hecht, 1938) which were the result of a need for a biostratigraphic zonation for use in the search for hydrocarbons. In France, Marie (1939, 1941a-d, 1965) published a series of papers on the foraminiferal fauna of the Aube and from the Pas de Boulonnais while in southern England, Khan (MS., 1950a; 1952) and Walters (MS., 1958) also described the foraminiferal fauna of the Gault Clay. In Holland, Ten Dam (1950) published one major work on Albian foraminifera. Other significant European works include those by Gawor-Biedowa (1969, 1972), who studied the Upper Albian to Turonian interval of Poland and Hermès (1979), who studied the Albian planktonic fauna of southern Spain.

In North America the work of Cushman and his associates was also stimulated by the increasing demands of the oil exploration industry. Between 1920 and 1950 they documented many of the Albian species from North America and Europe. More recently, Chamney (1973) described the Lower Cretaceous fauna of Canada while Ascoli (1976) documented the Mesozoic foraminifera and Ostracoda of the Scotian Shelf, Atlantic Canada.

During the last decade, Hart (1973a,b), Price (1975-1977), Magniez-Jannin (1975) and Carter & Hart (1977) have all published major contributions on the Albian foraminifera of northwestern Europe. Hart (1973a) discussed the macrofaunal and microfaunal zonations of the Gault Clay of southeast England with reference to the Copt Point,

Folkestone section and suggested zonal schemes based on both the foraminifera and Ostracoda of this section. He used these zonations, along with superfamily percentage diagrams, to illustrate the lateral changes in both the Lower and Upper Gault and Upper Greensand. Hart (1973b) documented the foraminifera of the Cambridge Greensand which he proved to be of Cenomanian age.

Price (1975) discussed the Albian palaeoenvironment of north-western Europe with the aid of selected species of foraminifera. He concluded that a mobile tethyan-boreal interface existed in the Middle and Upper Albian and also suggested that prior to this, in the Lower Albian, no marked current circulatory movements occurred. Price (1977a) reviewed the distribution and evolution of the genera Arenobulimina Cushman, 1927, Hedbergella Bronnimann & Brown, 1958 and Gavelinella Brotzen, 1942 in the Albian. He also (1977b) proposed a zonal scheme for the Albian of northwestern Europe and compared the macrofaunal zonation with this. Magniez-Jannin (1975) documented the foraminifera of the Aube district of France and also proposed a zonal scheme. This work documented very thoroughly the gradational nature of the evolution of many Albian species, especially those belonging to the Nodosariacea Ehrenberg, 1838. Carter & Hart (1977) discussed aspects of mid-Cretaceous stratigraphical micropalaeontology and proposed a zonal scheme for the Gault Clay and Cenomanian of southern England which they then applied to many other English sections. They also studied the evolution of the genera Arenobulimina Cushman, 1927, Hedbergella Bronnimann & Brown, 1958 and Gavelinella Brotzen, 1942.

Many of the above publications include details of planktonic foraminifera which have been studied extensively on a global scale due to their stratigraphic importance. The publications of Loeblich & Tappan (1961), van Hinte (1976), Longoria (1977), Longoria & Gamper (1977), Masters (1977) and Robaszynski & Caron (1979) are all of

major significance.

### Ostracoda

The first reference to British Albian Ostracoda was published by Williamson (1847), who figured five species from the 'chalk detritus' (Cenomanian) of Charing, Kent. This work was followed by the contributions of Jones (1849) and Jones & Hinde (1890) on British Cretaceous Ostracoda. They described many Albian species, most of which were collected from the Gault Clay of Folkestone, Kent. Chapman & Sherborn (1893) listed several species of Ostracoda from the Gault Clay of Folkestone and Chapman (1898) described several species of Ostracoda from the Cambridge Greensand of Cambridgeshire. During the nineteenth century comparable works were completed by European workers including Roemer (1840), Reuss (1846), Cornuel (1848) and Bosquet (1847, 1852). Nearly a complete century passed before Triebel (1938-1940) published several major taxonomic works on the Albian Ostracoda of Germany and described several new species. Mertens (1956) also described some German Albian Ostracoda.

At about this time in Britain Hughes-Clarke (MS., 1957) studied the Albian Ostracoda of southeastern England while in France, Deroo (1956) and Oertli (1958) published major taxonomic works.

All these publications culminated in the works of Kaye (1963-1966) in Britain, Damotte (1963-1977) in France, and Gründel (1964-1973) in Germany. These authors resolved many of the major taxonomic problems involving Albian Ostracoda and briefly discussed their stratigraphic and palaeoecological significance. It is these works that form the foundation of the present study.

Kaye published a series of major taxonomic works on both Lower and Upper Cretaceous Ostracoda. His work was initiated by a research project on the Lower Cretaceous Ostracoda of Yorkshire, which concentrated on the coastal section of Speeton, but also included a



brief analysis of the Red Chalk at Melton, North Humberside. This was followed by further research which concentrated on the Aptian and Albian stages of southern and eastern England and which resulted in the publication of several major works (1963d, 1964c, 1965c) on the taxonomy of Albian Ostracoda. Of these, his 1965c publication is of fundamental significance to this work as in this he described a large number of new Albian species. While Kaye researched into this topic in Britain, Damotte in France and Gründel in East Germany were also involved in the study of Lower Cretaceous Ostracoda. Unfortunately, this resulted in some duplication of new species; however, many of these problems were resolved by Damotte (1971b).

Damotte & Grosdidier (1963) and Damotte (1961-1977) have limited their research to the Aube region of France or to other areas in the Paris Basin. Similarly to Kaye they concentrated on the taxonomy of individual species and not on their stratigraphy or palaeoecology. However, Gründel (1964-1966), in describing the Lower Cretaceous Ostracoda from a series of boreholes from East Germany, gave detailed stratigraphic ranges of the species he described. Unfortunately he did not relate these to the macrobiostratigraphy.

All the above works, as has already been stated, have concentrated on the taxonomy of species and none has attempted to propose a detailed zonal scheme based on Ostracoda. However, during the last decade several authors have used this taxonomic base to propose tentative zonal schemes. These include Hart (1973a), who listed selected species from the Gault Clay of Folkestone and proposed a zonation which divided the Lower and Upper Gault into 5 zones, and Neale (1978) who summarised the existing knowledge on British Cretaceous Ostracoda and proposed a zonal scheme for the Lower Cretaceous in which he divided the Albian into two Zones. The zonal



scheme proposed by Bertram & Kemper (1971) is still the most refined of all the proposed schemes. It used the evolution of selected genera which were divided up into a number of chronospecies and chronosubspecies.

Although the taxonomy of Albian Ostracoda has been documented in detail, little regard has been attached to their biostratigraphy and this has resulted in a lack of precise information on species ranges which could be used in the definition of a zonal scheme. Several recent publications have concentrated more fully on the detailed stratigraphic distribution with respect to specific localities and precisely located horizons. These include the works of Kemper et.al. (1975), who recorded the detailed ranges of Upper Aptian and Lower Albian Ostracoda from the Hannover district of Germany, and Van der Wiel (1978), who recorded those of Upper Albian Ostracoda from Wissant, France. This general lack of precise stratigraphic detail in taxonomic works has led the present author to attempt to define a zonal scheme which is based on a similar amount of stratigraphic detail as many of the foraminiferal workers have used in order to define their zonal schemes.

### 1:3 Sedimentology

Five major lithological units have been described from northwest Europe, these facies have been ascribed different names in the various countries. These are summarised below:-

Fig. 1:4 A comparison of the terminology of the major lithological units.

| England                      | France                                   | Germany                         |
|------------------------------|--|---------------------------------|
| Gault Clay                   | Gault Clay                               | Gault Clay                      |
| Lower Greensand/<br>Carstone | Poudingue<br>ferrugineux/<br>Sables Vert | Hils & Rothenberg<br>sandstones |
| Upper<br>Greensand           | Gaize                                    |                                 |
| Red Chalk                    |  |                                 |
| Malmstone                    |  | Flammenmergel                   |

The Gault Clay facies was deposited over much of the northwest European continental shelf. It is generally a grey/blue clay but includes minor intercalations of limestone and/or greensand. The basal Gault Clay is generally sandier and is often transitional from the Lower Greensand. This facies has been shown by successive authors to have a diachronous base and a diachronous top, the most commonly quoted example of this being the younging of the basal bed from southeastern England towards Dorset and Devon. In the southern North Sea Basin, West Germany and the Aube, clays of Lower Albian age have been recorded. These overlie clays of Aptian age in the northern basins where, similarly to at Speeton, they form the topmost part of the Speeton Clay series. In the Aube, the Gault clay overlies sandstone of Lower Albian age.

The Gault Clay facies contains many beds, the boundaries between which are often marked by layers of phosphatic nodules. These layers of nodules have been proven by Owen (1971a, 1975) to represent breaks in sedimentation, the most marked of these occurring within the D.cristatum and H.orbigny Subzones.

The Gault Clay is normally underlain by the Lower Greensand, the topmost part of which, in England, has been ascribed a Lower Albian age

(Casey, 1961). The Lower Greensand facies represents the first marine incursion of Cretaceous age into the Wealden Basin. In England it extends as far north as Yorkshire and, along the east coast, the terms Carstone and Ferruginous Sand may be considered equivalent to it (Casey, 1961). In France the names Poudinge Ferrugineux and Sables Vert have been used to describe a similar lithological facies (Destombes et. al., 1977) as have the names Hils and Rothenberg Sandstones (Kemper, 1973) in Germany. All these various lithological units have been interpreted as representing a shallow, marginal marine environment. It has been termed greensand because of the general abundance of glauconite which gives it an overall greenish colour. The amount of glauconite varies greatly and in some sandstones it may be absent. Beds of nodules, bioturbation, and cross stratification are common features at many localities.

The Upper Greensand overlies the Gault Clay in the western part of the Anglo-Paris Basin (figs. 2:2; 2:4). A similar facies has also been recorded from West Germany in association with the Rhenanian massif (Kemper, 1973). Several workers, including Tresise (1960), Hancock (1969), and Ali (1974, 1976) have studied the sedimentology of this facies. Tresise described the lithology of the Upper Greensand of Wessex while Hancock described the Cretaceous transgressive sea of southwest England. This latter study included the results of a heavy mineral investigation of the Upper Greensand. Ali discussed the infillings in the Upper Greensand and the 'cobble conglomerate' of Beer, Devon. He interpreted the former as resulting from repeated reworking of deposits due to the tectonic uplifting of Beer ridge which, he stated, "continually changed the bathymetry of the region". He interpreted the 'cobble conglomerate' as a beach deposit.

Many authors have included sedimentological details in their attempts to correlate the Upper Greensand including Drummond

(1970), Kennedy (1970), Hart (1971, 1973b,c), Owen (1971b, 1975), Hamblin & Wood (1976), Carter & Hart (1977) and Hart et.al. (1979a, 1979b). In northeastern France the Upper Greensand (Gaize) has been briefly described by Juignet (1970, 1971) and Destombes et.al. (1977).

Many problems still remain with the dating of this lithological unit and various subzonal ages have been ascribed to it which have mainly placed it within the Upper Albian. However, major contradictions exist in the dates of various authors for the Upper Greensand of Dorset and Devon. This subject is not reviewed here as this research project adds little to the resolution of these problems.

Both the Gault Clay and Upper Greensand are overlain by the 'Glaucinitic Marl', which is itself diachronous, and is generally of Lower Cenomanian age but does extend up as far as the Middle Cenomanian (Hart pers.comm.1980). Hart (1973b) proved conclusively that the Cambridge Greensand is a contemporaneous deposit of Lower Cenomanian age, and not of Upper Albian age, as it had previously been considered.

The 'malmstone' (Owen, 1975) is equivalent to the 'flammenmergel' of West Germany (Price, 1977a). Kemper (1973) described this as a spiculiferous carbonate which exhibits strong evidence of bioturbation. He noted that the spicules had been mobilised to different degrees to form siliceous limestones, and that the base of this lithological unit is diachronous. Interfingering with the Neohibolites minimus clays has been recorded from several localities. He concluded that this facies was deposited in warm, shallow-water conditions, some distance from shore. It was considered by Price (1977a) to be an open-sea equivalent of the Upper Greensand.

The Red Chalk of the southern North Sea Basin consists mainly of red limestones but also includes marls, clays and gritty beds, some of which are not red. The precise dating of this lithological unit still remains problematical but the bulk of it is of Upper Albian age.

Middle Albian and Lower Cenomanian ages have also been ascribed to it. The more calcareous units of the Red Chalk were formed from organically derived carbonate and at several localities these have been very extensively bioturbated (Eller pers.comm., 1979). This lithological unit overlies both the Carstone and the Speeton Clay and is overlain itself at every locality by white Chalk. At many localities the Red Chalk appears nodular, and this may be the result of a slow depositional rate. At many localities it may also be associated with the formation of hardgrounds (Kennedy & Garrison, 1975).

Although Albian biostratigraphy has been very extensively studied little has been published on Albian sedimentology. Few extensive palaeoenvironmental models have been published and little has been recorded of the sedimentological structures, diagenesis, and provenance of the sediment.

#### 1:4 Palaeogeography

Several authors have published palaeogeographic reconstructions for the Albian Stage of northwestern Europe which have all been based on the presence and absence of sedimentary deposits. Absence has been interpreted as indicative of land whereas it should more correctly be interpreted as indicative of non deposition and/or total removal of the sedimentary cover by erosion. These reconstructions are briefly discussed below and have been summarised (figs. 1:5 to 1:8) to produce a palaeogeographic reconstruction for each of the Albian Substages across northwestern Europe. The distribution of the major lithological units has also been summarised on these reconstructions.

Kirkaldy (1963) was the first author to attempt a palaeogeographic reconstruction for the Albian of northwestern Europe. His was based on the work of Casey (1961) and was, therefore, limited to southern England and northwestern France. In this reconstruction he envisaged

Fig. 1:5 A generalised reconstruction of the palaeogeography and the distribution of sedimentary facies in the Upper Aptian/Lower Albian of N.W.Europe.





Fig. 1:6 A generalised reconstruction of the palaeogeography and the distribution of sedimentary facies in the Middle Albian of N.W.Europe.

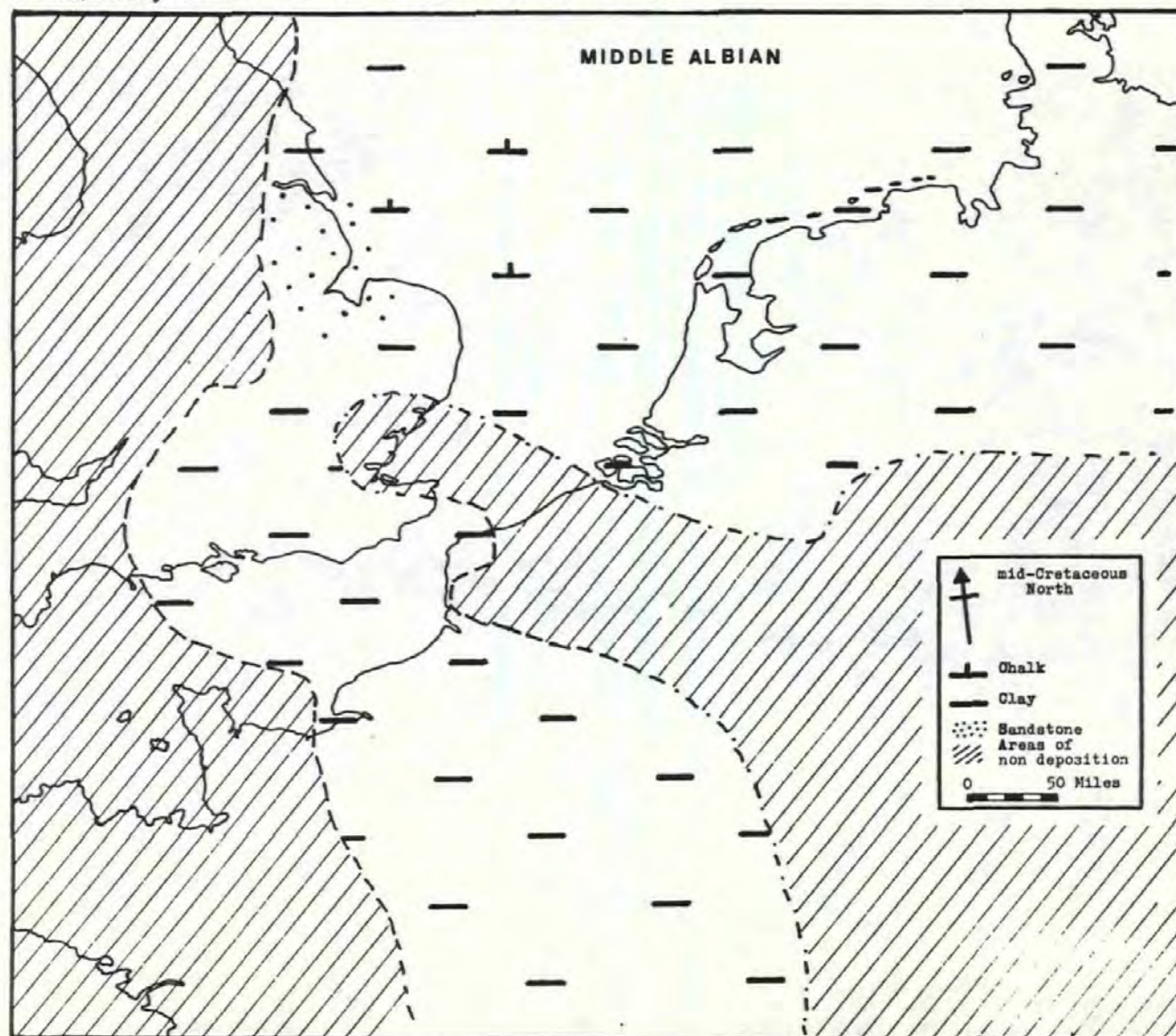




Fig. 1:7 A generalised reconstruction of the palaeogeography and the distribution of sedimentary facies in the Upper Albian of N.W.Europe.

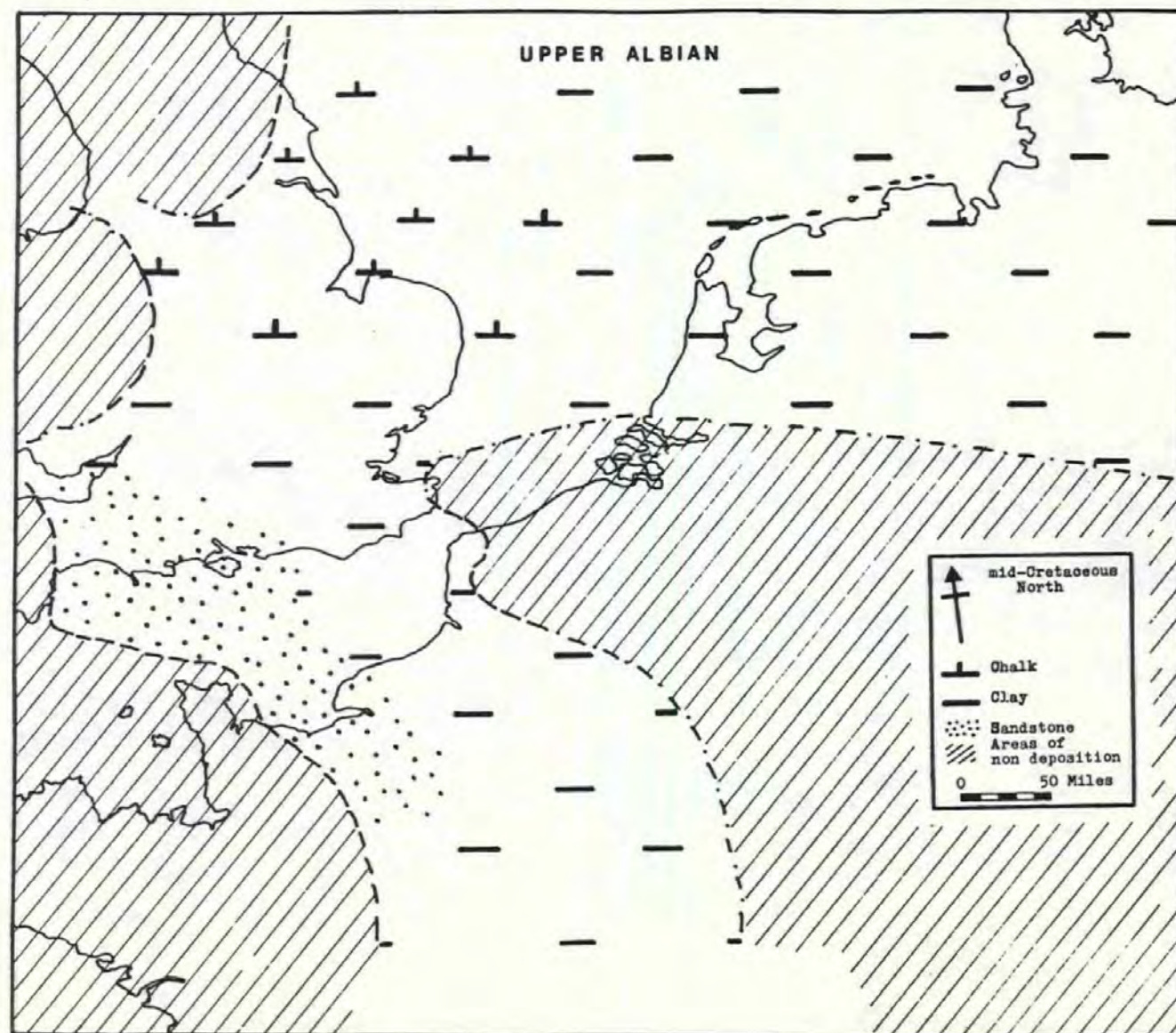
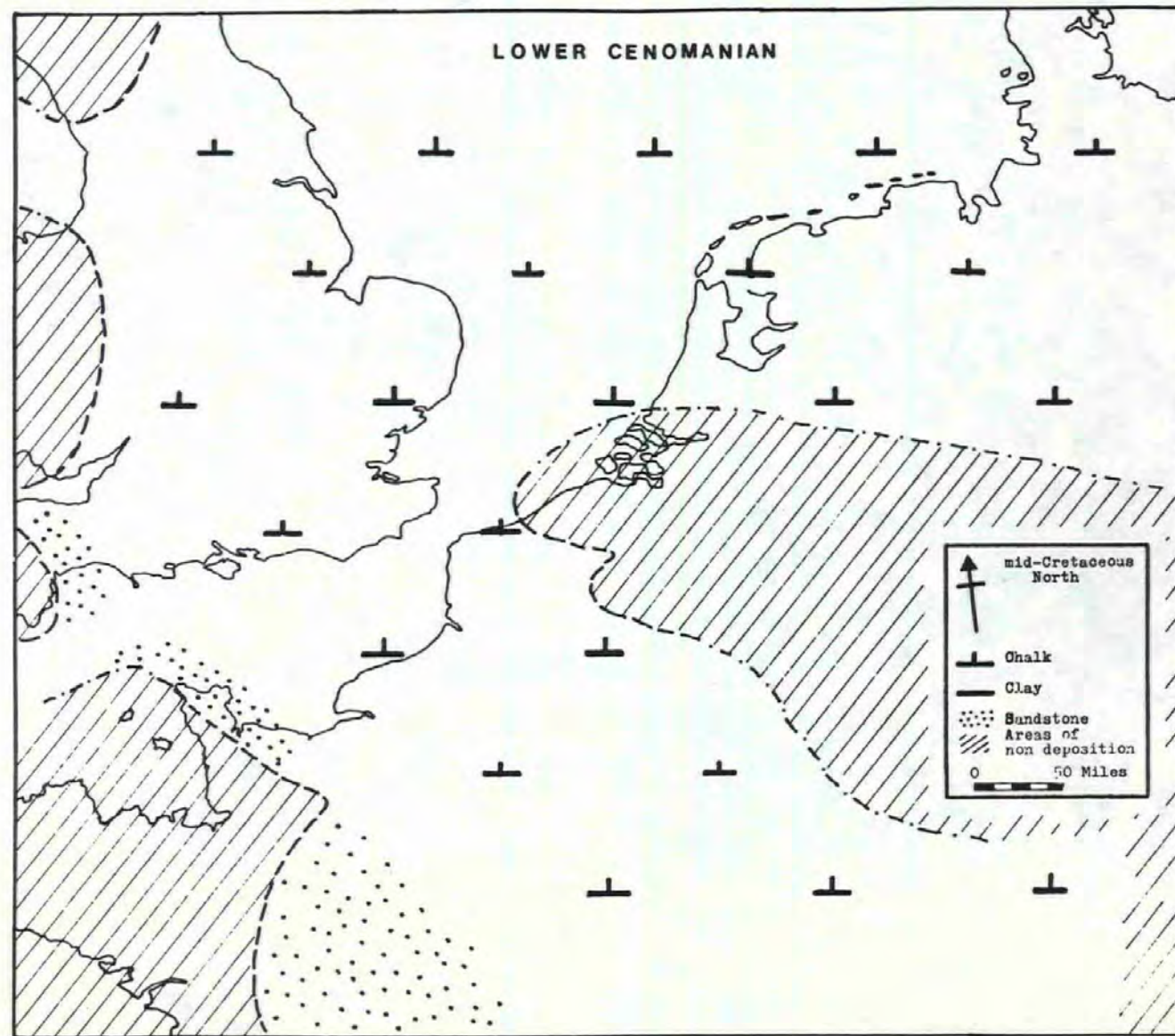




Fig. 1:8 A generalised reconstruction of the palaeogeography and the distribution of sedimentary facies in the Lower Cenomanian of N.W.Europe.



a marine connection through the Cornubian/Armorican massif to the open Atlantic and it is this connection that provided the major point of controversy in subsequent publications. Kirkaldy stated that the first connection between the southern North Sea Basin and southern England did not occur until the Upper Aptian (nutfieldensis Zone). Subsequent to this, Bennison & Wright (1969) published a reconstruction based on the work of both Casey (1961) and Kirkaldy (1963).

Juignet (1971) summarised the distribution of sedimentary facies in the Pays de Caux and included localised reconstructions for the Upper Aptian, Lower Albian, Upper Albian, and Cenomanian. Juignet was the first author to illustrate the transgressive nature of Albian sedimentation. Kemper (1973) published detailed reconstructions for the Aptian of Germany, and Juignet (1973) published reconstructions for the Upper Aptian and Lower Albian of southern England and north-western France. The reconstructions outlined above have been incorporated with those of Naylor & Mounteney (1975) and Pegrum et.al. (1975) to produce the Upper Aptian and Lower Albian (fig. 1:5) maps of northwestern Europe.

The reconstruction of the Middle Albian (fig. 1:6) has been almost entirely based on the published reconstructions of Owen (1971b, 1975) and Bennison & Wright (1969), and that for the Upper Albian (fig. 1:7) on the works of Bennison & Wright (1969), Juignet (1971, 1973) and Hancock (1969). The Lower Cenomanian reconstruction (fig. 1:8) is based on that of Damotte (1975) and Weaver (MS., 1978). The distribution of the major lithological units has been summarised from the above information and from the publications of Rhys (1974) and Rawson et.al. (1978).

These reconstructions illustrate the drastic changes that occurred in the palaeogeography and the distribution of lithological units during the Albian Stage in northwestern Europe. This change

is primarily from the dominantly clay and sand deposition of the Lower Cretaceous to the much more widespread depositional environment of the Chalk Sea.

#### 1:5 Controls of deposition

Owen (1975) summarised these for the Gault Clay of southern England and divided them into two categories: tectonic and bathymetric. These are discussed separately below:

Owen (1975) thought that the block faulting and folding of the Upper Jurassic and early Lower Cretaceous (Cimmerian) had restricted the marine incursion of the Lower Cretaceous, and that the erosion of these uplifted areas provided the coarse detritus for much of the Lower Cretaceous, including the Lower Greensand. Casey (1961) recorded a number of minor folding phases as late as the L.tardefurcata Zone. After the Lower Greensand, less turbulent water conditions prevailed (Owen, 1975) which permitted the accumulation of the soft muds of the Gault Clay. During the deposition of the basal Gault Clay the sedimentary basin extended rapidly to the A.intermedius Subzone dimensions (Owen, 1975).

During the Middle Albian sedimentation in the Anglo-Paris Basin was controlled by a number of parallel ridges and troughs (Owen, 1971a), but the effect of these ridges on sedimentation was minimal by the Upper Albian. Owen also regarded the D.cristatum Subzone as a major period of submarine erosion which he thought 'planed off' the upper surface of the Lower Gault throughout the Anglo-Paris Basin and beyond. These periods of 'current scour' continued in the region of the London Platform throughout the D.cristatum and H.orbigny Subzones (Owen, 1975). In the H.varicosum Subzone he thought that thick and rapid sedimentation prevailed and that this high rate of sedimentation continued until the Cenomanian. Owen also recorded a phase of 'low amplitude'

folding during the C.auritus Subzone and another during the early Cenomanian. The latter resulted in the marked erosional surface that commonly occurs at the base of the Cenomanian.

The change in the depth of the shallow, epicontinental Albian sea had a profound effect on both the fauna and the sedimentation. Hays & Pitman (1973) proposed a model for the change in depth of the Cretaceous Sea which was based on a volumetric analysis of mid-oceanic ridges, and demonstrated that the mid-to Upper Cretaceous transgression and subsequent regression may have been caused by a contemporaneous pulse of rapid spreading at most of the mid-oceanic ridges between 110 to 85m.y. They suggested that during the interval from the Aptian to Cenomanian the sea gradually transgressed the land. Another model for the change in the sea depth during the Cretaceous was proposed by Hancock & Kauffman (1979). They also envisaged a gradual deepening of the sea during the Albian Stage with this transgression attaining its global peak in the H.orbignyi Subzone, followed by a minor regressive phase in the C.auritus Subzone. This was followed by a further transgressive phase in the S.dispar Zone which culminated in the major, early Cenomanian, transgression. Cooper (1977) suggested that the transgressive and regressive phases during the Albian were rapid and not gradual as Hancock & Kauffman proposed. He postulated that two major transgressions and three major regressions occurred during the Albian Stage, which compares to the one gradual transgression proposed by Hays & Pitman, and to the one major transgressive phase with minor regressive phases that Hancock and Kauffman proposed.

The latter authors have estimated the relative depth of the Albian Sea and several authors have suggested more absolute depths on palaeontological data. A new model for both the relative and absolute depth of the Albian Sea is discussed in the concluding chapters.

The biostratigraphy of the Albian Stage, and to a lesser extent the sedimentology, have been discussed in great detail by previous authors. A high degree of stratigraphic resolution has been achieved by the use of both the Ammonoidea and foraminifera and this information has been compared and modified by Price (1977b). No precise stratigraphic zonation has been proposed based on Ostracoda and only one attempt (Hart, 1973a) has been made to correlate the biostratigraphy of the foraminifera and Ostracoda. The evolution and migration of the microfauna is a topic which, until the last decade, has generally been neglected. There has been little attention given to the study of provincialism of Albian faunas in northwestern Europe except for the work of Price (1975, 1977b).

## CHAPTER TWO

### METHODS

#### 2:1 Procedure

The aim of this study was to refine Albian biostratigraphy, especially that of southern England. This could not be achieved without a working knowledge of the biostratigraphy of the geographically adjacent areas and hence sections from the southern North Sea Basin, Germany, and France were collected to augment those from southern England.

Previously, the macrofauna, especially the Ammonoidea, have been regarded as the most important stratigraphic markers. Thus, the integration of the macrofaunal zonal scheme is an essential part of any microfaunal zonation of the Albian. To achieve this the most precise macrofaunal information was collected and the samples were directly related to the microfaunal data. However, because microfossils are generally ubiquitously distributed within the Gault Clay they are generally of greater stratigraphic significance than the macrofauna. This is especially true where the macrofauna is rare or sporadically distributed (eg. the topmost Upper Albian, H. varicosum Subzone, to lowest Cenomanian interval).

The studied sections were specifically chosen to fulfill the aims outlined above and those listed below:-

- (i) To collect the most complete (stratigraphically) of the sections mentioned by d'Orbigny (1842) when he defined the Albian Stage.
- (ii) To provide a thorough macrofaunal framework for these sections.
- (iii) To collect the most chronologically continuous sections.
- (iv) To illustrate the effect of both vertical and lateral

facies changes on the microfaunal population.

- (v) To illustrate the lateral change in populations within one facies.
- (vi) To provide detailed information on the uppermost Albian Subzones.

## 2:2 Sample collection

A total of 483 samples were examined for their microfauna. These were collected, observing the principles outlined above, from southern England, Norfolk, Yorkshire, the southern North Sea Basin, Germany and France. These samples were collected, in most cases, at one metre intervals. However, in condensed sequences a closer sampling interval was required. The position of the samples in relation to the lithological units and to the macrofaunal information and bed numbers (where applicable) has been documented on the detailed sections (figs. 3:2 to 3:10).

The size of each sample was determined by the method of collection. The samples from Glyndebourne and from the M.25 sections were normally large enough to provide an adequate fauna. Where this was not the case, and the sampling interval was less than one metre, intermediate samples were also examined. The well cutting samples from the southern North Sea Basin were usually too small to provide an adequate ostracod population as they generally represented a ten foot, or larger interval. All these samples also contained a high proportion of 'downhole' contamination.

The sections from Folkestone were collected in great detail. Both Copt Point and East Wear Bay were collected at less than a one metre sample interval. All these samples were precisely located with respect to the macrofaunal zonation and to the lithological units.

Each sample consisted of approximately one kilogram of sediment.

This sample size was standard for all the surface localities collected in this study. The sections at Compton Bay, Seaton, Hunstanton, Melton, Speeton, Cauville, and Wissant were also collected using a one metre (or less) sample interval. Comparative material was collected from several localities in the Aube district of France and from the Hannover district of Germany.

Samples larger than 1 kg. in weight were collected from sections containing an impoverished or poorly preserved fauna. These larger samples were mainly necessary in the Lower Greensand, the basal Gault Clay, and the Upper Greensand. Samples from the Upper Greensand were preferentially collected from the least decalcified horizons. The sampling method for each of the sections is summarised below:-

1) Spot samples:

a) Coastal sections

Copt Point, East Wear Bay, Compton Bay, Seaton, Hunstanton, Speeton, Cauville, Wissant.

b) Quarry sections

Melton, Bois de Perchois, Courcelles, Villemoyenne, Altwarmbüchen, Vöhrum.

2) Borehole samples:

Glyndebourne (continuous).

M.25: 16/3, 1967/1, 113/2, 3/1 (all U4's).

Folkestone: IIa (U4's).

Southern North Sea Basin: 49/24-1, 49/19-1 (well cutting samples).

3) Several sections collected by Dr. H.G. Owen, which are now deposited in the British Museum, were also briefly examined for their microfauna. These were from Fenn Pond Lane (Owen, 1975) and East Wear Bay. One section from Shapwick, Devon was also collected during the tenure of this study and information from



this has been published (Hart et.al., 1979). Several sections from eastern England were made available by the I.G.S. for microfaunal examination. None of these sections has been described in this thesis and no conclusions have been drawn from them, although, some specimens from these sections have been photographed.

### 2:3 Processing

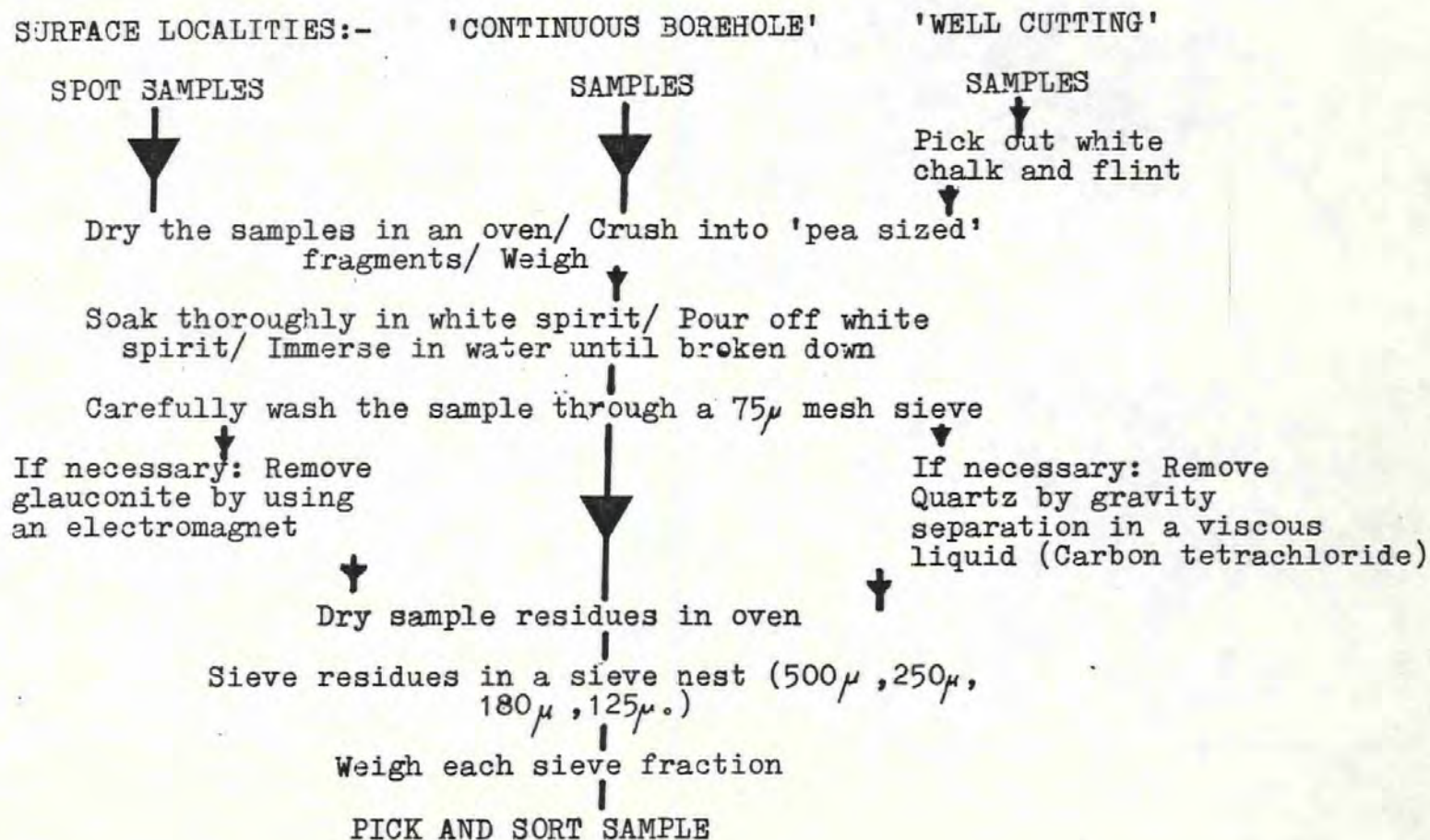
The processing techniques used in this study are familiar in micropalaeontology and need little explanation. All the samples broke down with the use of white spirit, and the steps used in this process have been summarised in fig. 2:1. Care was always taken to avoid contamination and the destruction of the more fragile specimens.

Before processing the well cutting samples the larger fragments of white Chalk and flint were removed by picking to avoid unnecessary 'down-hole' contamination.

### 2:4 Picking

After sieving the dry residue and weighing each size fraction, the samples were picked for microfauna using a damp 000 sable-haired brush and a picking tray. In the majority of samples, foraminifera greatly outnumbered Ostracoda. This resulted in the need to pick a much larger proportion of each sieve fraction for Ostracoda than for foraminifera. The proportion of the residue picked to gain an adequate number of planktonic foraminifera varied greatly, and in general a smaller amount of residue was picked in the higher Albian Subzones. From every sample, approximately 300 benthonic foraminifera and 100 planktonic foraminifera were picked. Where the samples were large enough approximately 300 Ostracoda were picked. The 500,250 and 180  $\mu$  fractions of the majority of samples were completely picked for Ostracoda, however, the 125  $\mu$  fraction was normally too large to

Fig. 2:1 A flow diagram indicating the order of processing stages.



pick completely.

Because of the great variation in the grain size of the lithological units examined in this study, it was not possible to pick a consistent percentage of each of the sieve fractions. The amount of each sieve fraction that was picked has been recorded, but this information is not included in this thesis. Only the absolute number of specimens per sample has been included (Appendix I). The aim was to pick a representative fauna for both biostratigraphic and phylogenetic study.

In conclusion, the variability of the sediment grain size, abundance of specimens, and size of samples has not enabled the author to make comprehensive quantitative analyses. The emphasis has, therefore, been placed on the absolute number of specimens and the total range of species. Only in the Glyndebourne borehole has a quantitative analysis been attempted.

## 2:5 Photography

The processing technique normally removed most of the sediment from specimens. Further cleaning was completed using a moist brush with water or dilute Hydrogen Peroxide while large lumps of sediment were prised off using a sharp needle.

Specimens were mounted on metal stubs using either 'Kodaflat' photographic glue or double-sided tape. In the latter case the glue was dissolved using Xylene. Most of the glue was then removed from the surface of the tape leaving only a very thin layer. This method produced a very even background on which to mount the specimens.

The specimens, once mounted, were coated with approximately 100 Å of gold in a "sputter coating unit" and photographed using a Scanning Electron Microscope (JEOL J.S.M.35C). The negatives were then developed using Acutol developing agent, enlarged, printed and glazed.

## CHAPTER THREE

### LOCALITY DESCRIPTIONS

The Gault Clay and Upper Greensand are exposed at many localities along the Channel coastline and there are many well documented inland sections. Along the East coast exposures are limited. Most of the British localities have been described fully either by Jukes-Browne & Hill (1900), Casey (1961), Owen (1971a, 1975), or by Carter & Hart (1977). In this study, only the most significant coastal exposures were examined and these were supplemented by the collection of two coastal sections from northwest France. Comparative material was also collected from the Aube district of France and from the Hannover area of West Germany. The majority of the material examined in this study was from boreholes in southern England, however, samples from a further two boreholes from the southern North Sea Basin were also examined (fig. 3:1).

#### ENGLAND

##### Folkestone, Kent

Three localities from Folkestone were examined for their microfauna. Two of these were coastal, the other inland.

##### Copt Point (TR 240 364): fig. 3:3

This coastal section was one of a number mentioned by d'Orbigny (1852) in his original definition of the Albian Stage. It has subsequently been studied in great detail by a large number of authors and major contributions have come from Price (1874), Chapman (1898), Jukes-Browne & Hill (1900), Casey (1961), Owen (1971a, 1975), and Hart (1973a). Walters (MS.), Khan (MS.), Hughes-Clarke (MS.), and Price (MS.) have also studied this section.

A total of thirty eight samples were collected from this section which is situated directly below the Car Park next

Fig. 3:1 An outline map of N.W.Europe showing the distribution of comparative sampling localities.

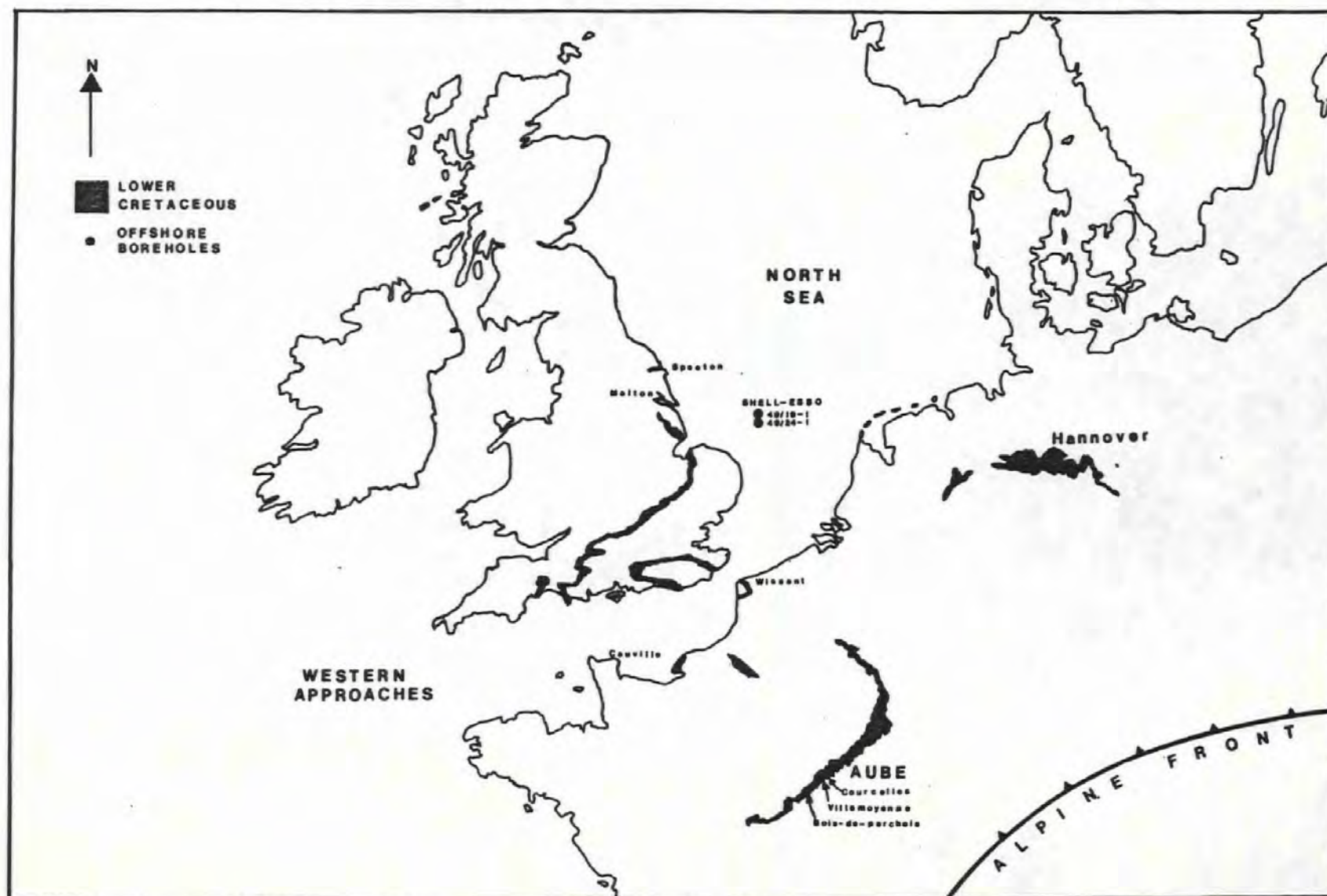




Fig. 3:2

Key to the Lithological logs.

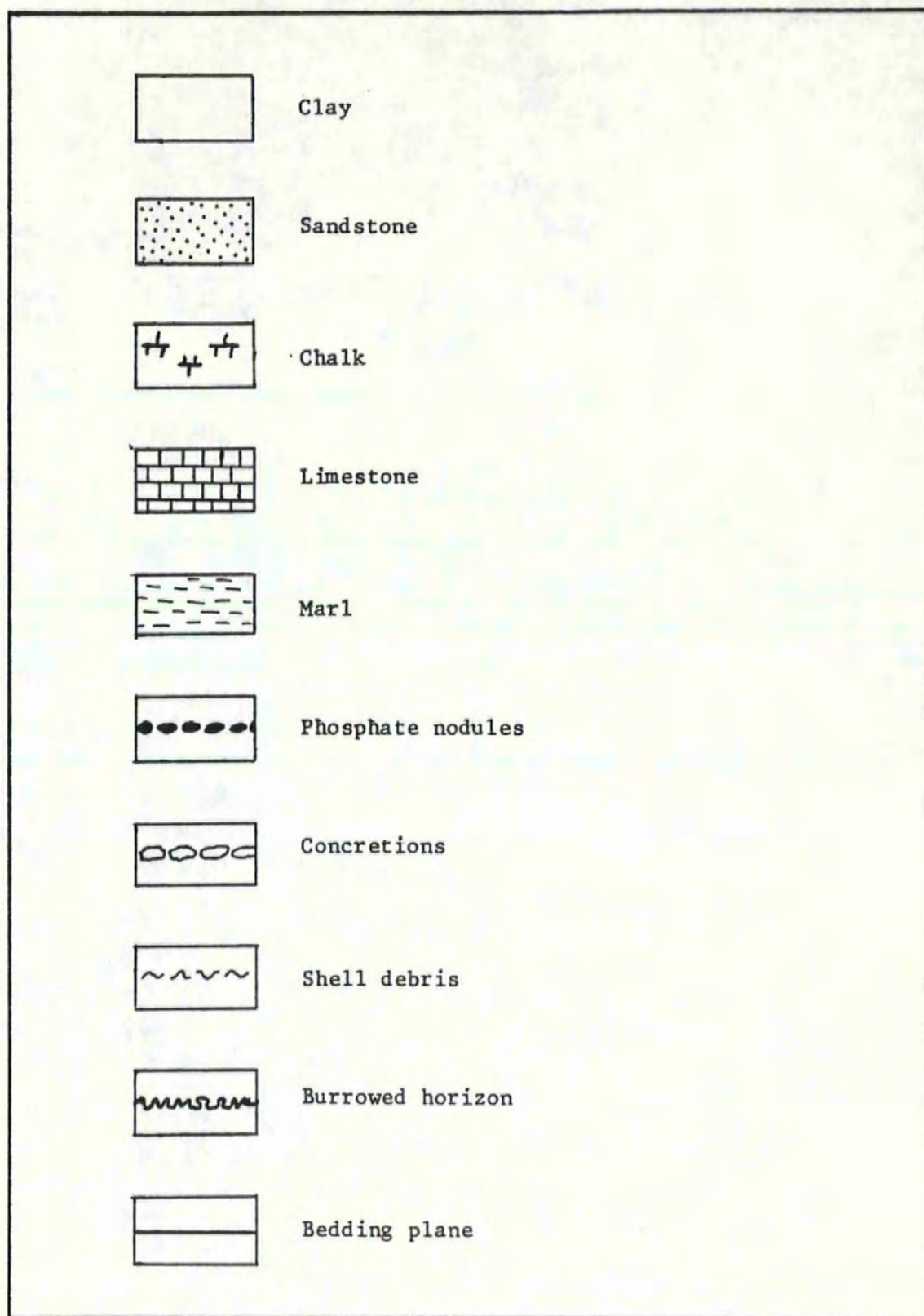


Fig. 3:3 A detailed lithological log of the three Folkestone sections which shows the position of the sampling localities.

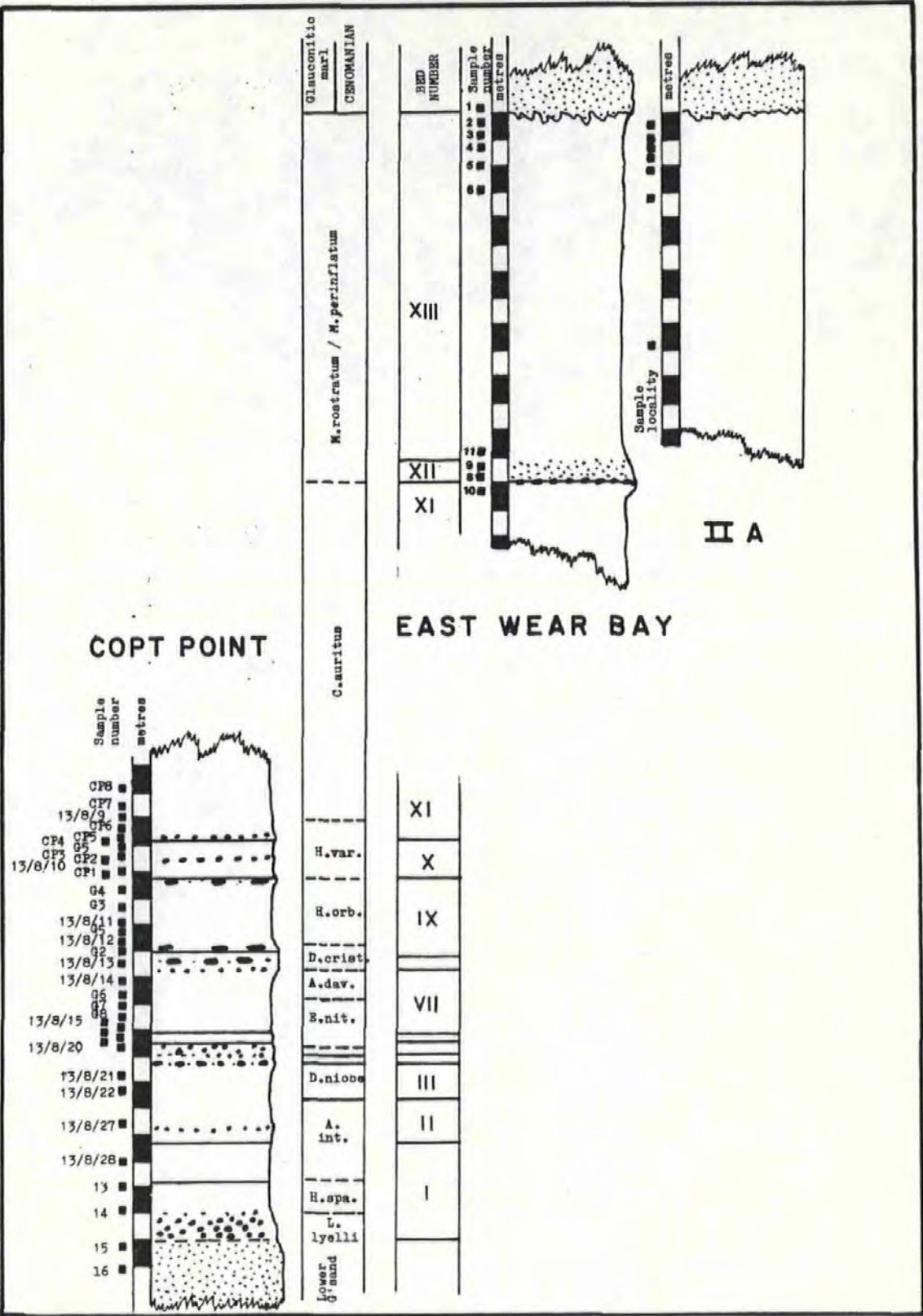
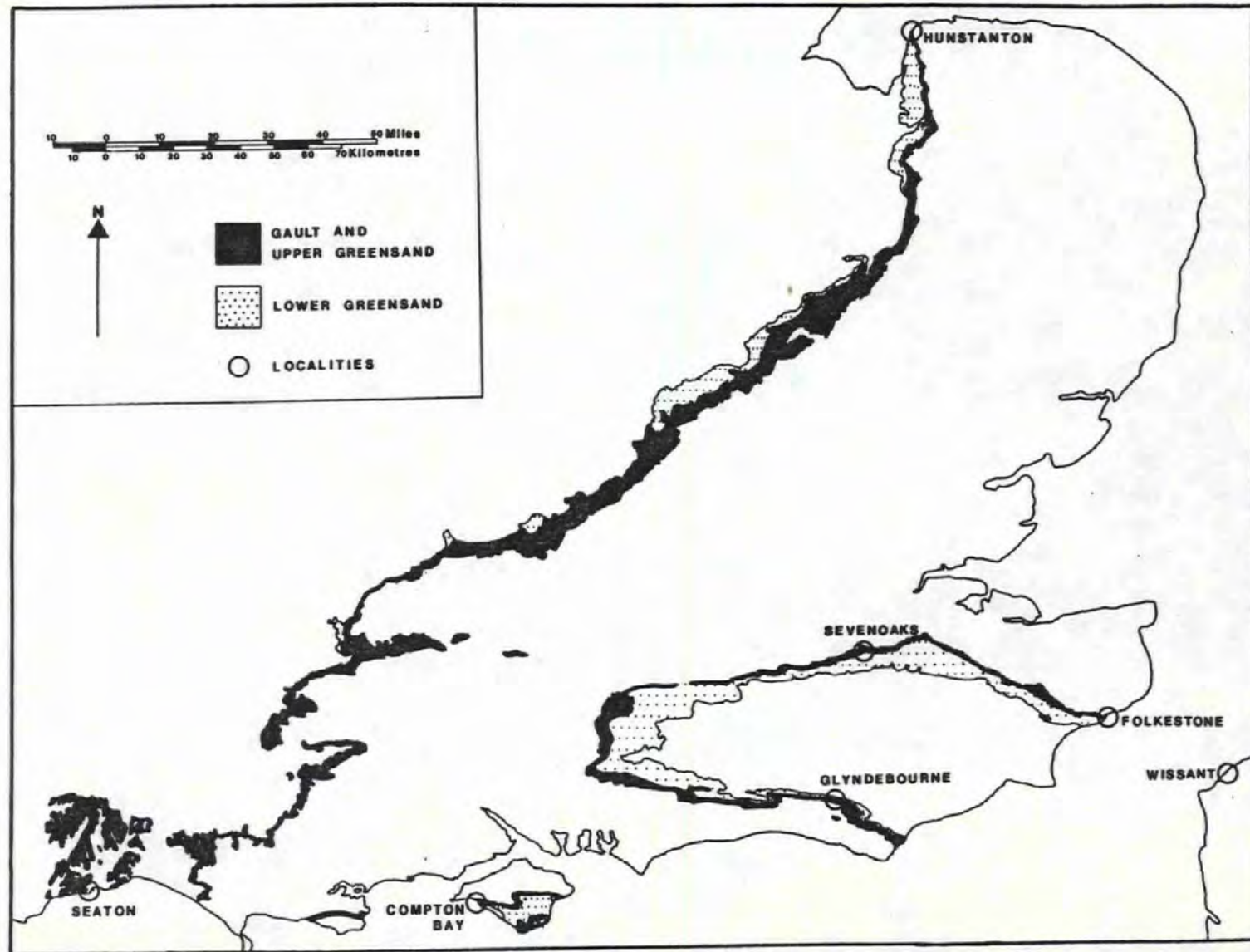




Fig. 3:4 An outline map of southern England showing the distribution of the major sampling localities.





to the East Cliff Pavilion. The collection of this section was supervised by Dr. H.G. Owen and thus a direct correlation with the macrofaunal zonation is possible (fig. 3:3). This section comprises the topmost part of the Lower Greensand (Folkestone Beds) and the basal half of the Gault Clay up to the level of the C.auritus Subzone.

Two other major sections were studied to provide material from the C.auritus Subzone and the S.dispar Zone. Several other minor localities were collected but their precise stratigraphic horizon could not be ascertained. These included samples from the small pit directly below the Coastguard Station at Copt Point, which later proved to be soliflucted Glauconitic Marl (Owen; pers.comm., 1979) and not Bed XII as Hart (1973a) had previously been led to believe. Other sections were collected from the cliff directly below the Car Park which is situated between Martello Towers Nos. 1 & 3. The sections of Beds XI, XII & XIII described by Owen (1975) below Martello Towers Nos. 1 & 3 were not visible during the course of this study.

The foraminifera of this section have been studied extensively and several zonal schemes have been proposed based on this section. The most recent of these was proposed by Hart (1973a) and this was later amended by Price (1977b). However, several anomalies exist between these two schemes and these are further complicated when the zonation proposed by Carter & Hart (1977) is considered. The major one of these problems is related to the position of the C.auritus Subzone in relation to the foraminiferal zonation. The base of this Subzone was placed above the base of Bed XI by Owen (1975) and this was followed by Price (1977b). However, Hart (1973a) followed Spath (1923) in placing the whole of Bed XI in the C.auritus Subzone. This problem is further complicated by the view of Morter (1979, pers.comm.) who suggested that the base of the C.auritus Subzone might be even higher than Owen (1975) suggested. This latter view has been confirmed in this study. The top of the C.auritus Subzone

has previously been placed at the top of Bed XII of Folkestone but this boundary is here considered to be within the S.dispar Zone, the lower boundary of which should be placed at the base of Bed XII. Morter (pers.comm., 1979) considered this change to be valid. The position of this zonal boundary is especially important when considering the uppermost Albian species ranges of Hart (1973a), Price (1977b), and Carter & Hart (1977). The H.cristatum Subzone, which according to Owen (1971a) represents a major hiatus, was placed in the Upper Albian by Owen (1971a). This change was incorporated in the zonation of Price (1977b) but not in that of Hart (1973a). Again this is important when interpreting the range charts of both these authors and that of Carter & Hart (1977).

#### East Wear Bay

This coastal section is situated on the fore-shore approximately fifty metres beyond the second concrete 'toe weighting'. At the time of collection this section, which consists of a complete sequence from the top of Bed XI to the 'Glaucinitic Marl' (Owen, 1975), the majority of Bed XIII was obscured by sand. A total of thirteen samples were collected from this section (fig. 3:3) under the supervision of Dr. H. G. Owen. A complete section collected by Dr. H. G. Owen, and which is now deposited in the British Museum, was also examined and information from this is included on the range charts.

#### Castle Hill

Samples from a borehole (IIa) at Castle Hill were made available by Kent County Council Highways Department. It was drilled in 1968 during a survey for the Cheriton-by-pass and penetrated the basal few metres of the Chalk, the 'Glaucinitic Marl', and the top six metres of the Gault Clay (fig. 3:3). The precise nature of the contact between the 'Glaucinitic Marl' and the topmost Gault Clay was not recorded on the well log and as this could quite easily be a

slumped contact, the information from this borehole has not been included on the range charts.

Glyndebourne, Sussex (TQ 442 114): fig. 3:5

An I.G.S. borehole located 1270 yards S.S.W. of Ringmer Church, Ringmer, was drilled in 1968 to provide a continuous section through the basal Chalk, Gault Clay and topmost Lower Greensand. The Gault Clay at this locality is 105m. thick (fig. 3:5). Cored samples taken at  $\frac{1}{2}$  metre intervals were provided for this project. Owing to the large number of samples provided they could only be studied at one metre intervals and only when insufficient numbers of specimens, or important stratigraphic horizons occurred, did the author study the samples at  $\frac{1}{2}$  metre intervals.

Dr. A. Morter provided the macrofaunal analysis of this borehole from which he has proposed a zonation (fig. 3:5). Below a depth of 92 metres the macrofauna was abundant, but above this level few diagnostic species were recorded and hence the macrofaunal zonation is only tentative. Both the detailed microfaunal and macrofaunal analyses will be published at a later date. A brief summary of this information will be included in the updated Lewes Memoir. The zonation provided by Morter is directly comparable (Morter; pers.comm. 1979) to that of Owen (1971a, 1975) and this section can therefore be directly related to the Folkestone and M.25 sections. This comparison indicates the probable absence of the A. daviesi Subzone and a faster rate of sedimentation in the Upper Albian. It is also clear that no direct sedimentological equivalent of Bed XII of Folkestone is present at Glyndebourne.

M.25 Boreholes (figs. 3:6, 3:7)

These four boreholes (U.4's) were sunk in the Sevenoaks, Kent area in 1969 by Kent County Council Highways Department in a

Fig. 3:5 A detailed lithological log of the Glyndebourne section showing the position of the sampling localities.

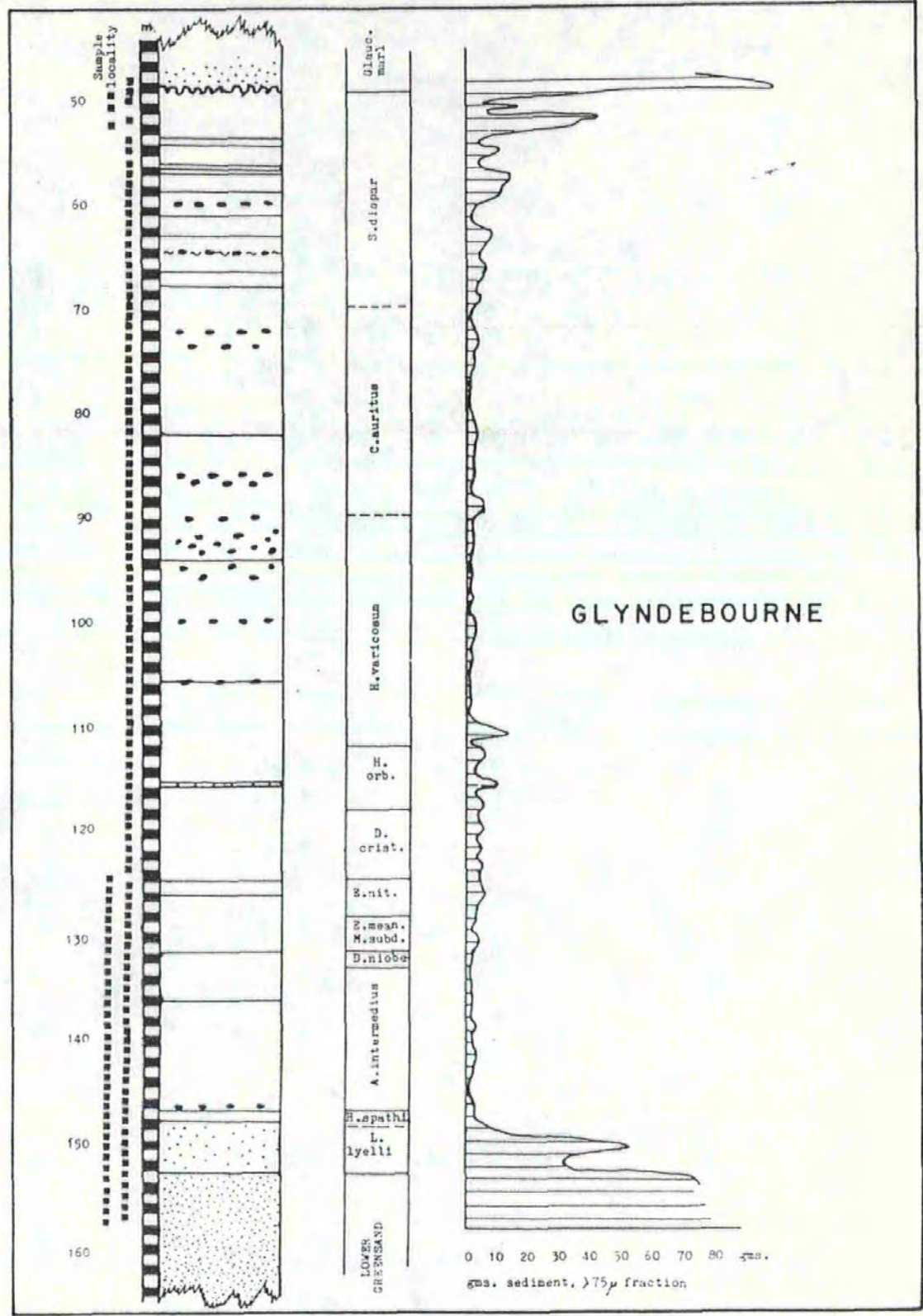




Fig. 3:6 A map of the Middle and Lower Cretaceous of the Sevenoaks area showing the distribution of the four M.25 borehole sections.

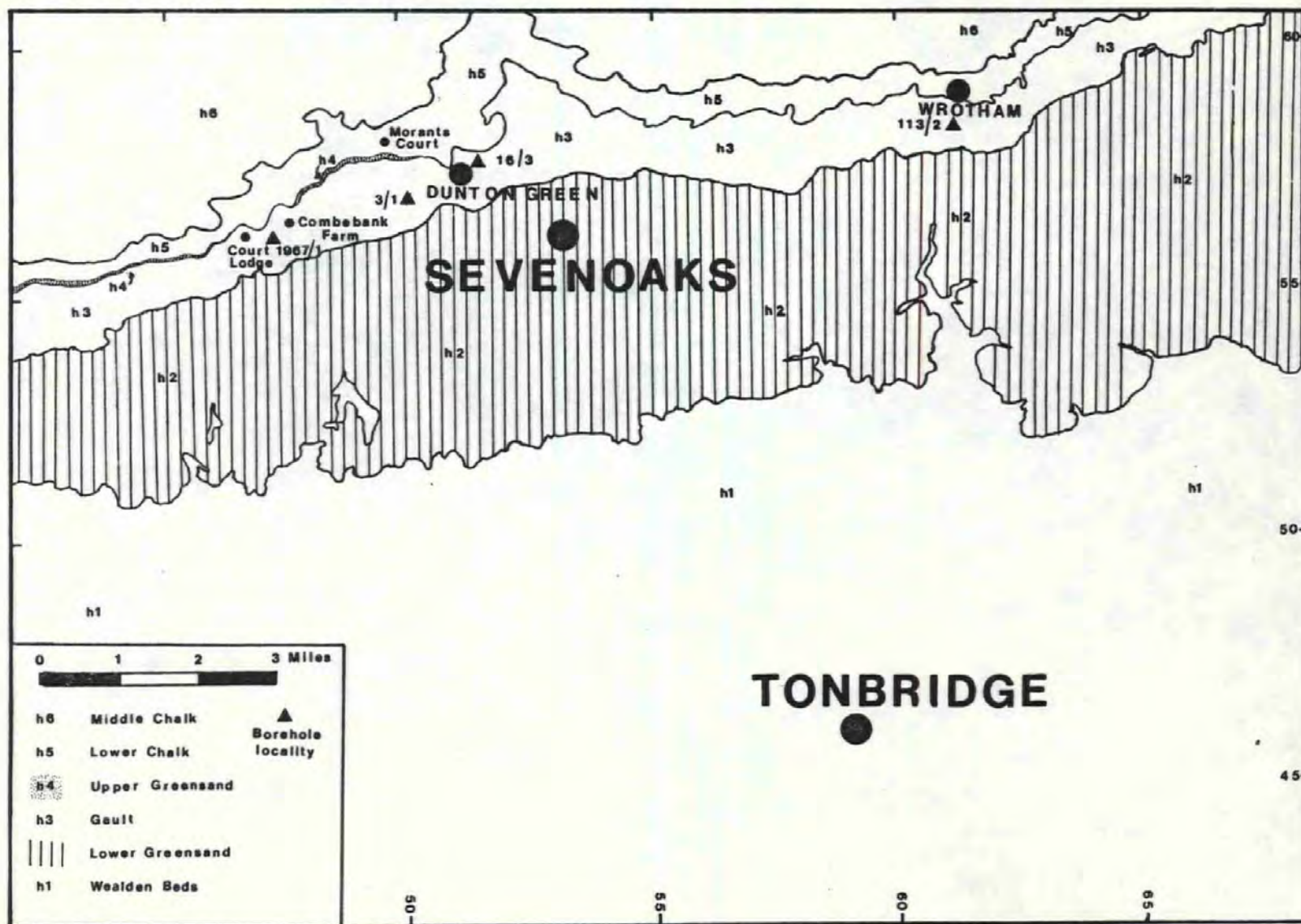
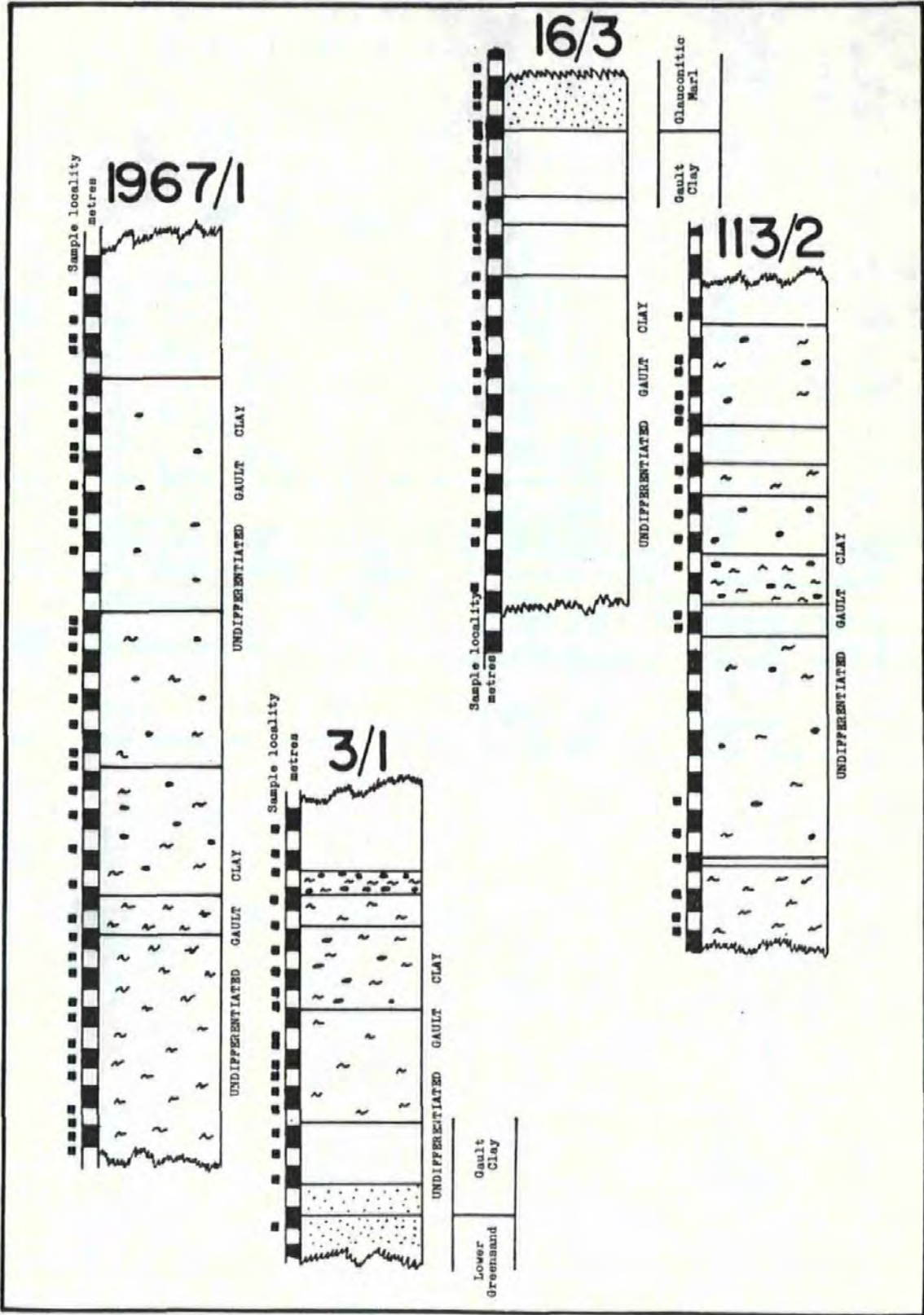


Fig. 3:7      Lithological logs of the four M.25 borehole sections showing the sampling intervals and the distribution of samples.



preliminary survey for the M.25 motorway. All the boreholes were situated close to the present route of the motorway.

Samples from these boreholes were studied at one metre intervals where this was possible. The sections were mainly in the Upper Albian but provide an almost complete section through the Gault Clay from the Lower Greensand to the 'Glaucónitic Marl'. Only brief lithological logs were provided with the samples and these contained no details of the macrofauna. It was therefore necessary to approximately date the sections by referring to the works of Owen (1971a, 1975). Owen (pers. comm., 1979) also provided detailed information on the macrofaunal zonation of the nearest surface localities to these boreholes (fig. 3:7) and it is these details that are discussed below, as minimal information can be interpreted from the lithological logs (fig. 3:7).

16/3 (TR 515 577) Dunton Green Railway Bridge

This borehole was situated to the East of Dunton Green and was sunk on the proposed route for the Motorway. Twentyfour metres of Gault Clay were recorded, which, according to Owen (pers. comm. 1979), should all be of S. dispar zonal age. Owen also suggested that the base of this section would be above the level of the C. auritus nodule bed, which is a prominent marker horizon in the north Kent and north Surrey districts. The 'Glaucónitic Marl' is present at the top of this section.

113/2 (TR 585 610) Wrotham Road Bridge

This borehole was sunk to the west of the M.25/A.20 intersection through a 32.5 metre section of Gault Clay. Neither the Lower Greensand or the 'Glaucónitic Marl' were recorded from this section.

Owen (pers. comm., 1979) has indicated that adjacent to this locality, the H. varicosum Subzone is more than 27 metres thick and that the H. orbigny Subzone is 2 metres thick. He did not record the



C.auritus Subzone in the motorway workings at this locality.

Unfortunately an 8 metre sample gap is present in this section which spans the H.varicosum/H.orbigny subzonal boundary.

1967/1 (TR 561 473) Brasted Hill Road

This borehole was sunk near the disused railway, Brasted Hill Road, through 44 metres of Gault Clay. Neither the Lower Greensand or the 'Glaucinitic Marl' were recorded from this locality.

Owen (pers.comm., 1979) recorded that at nearby Combebank, to the east of Brasted Hill, the H.varicosum Subzone is extremely thick and that at the intersection of the motorway route and Brasted Hill Road it is greater than 26 metres in thickness. At this locality the H.orbigny Subzone was recorded, by Owen, to be 4 metres thick.

3/1 (TR 569 500) Sevenoaks-by-Pass Interchange

This borehole was sunk at the site of the Sevenoaks-by-Pass Interchange through 22 metres of Gault Clay. At the base of the section the Lower Greensand was recorded.

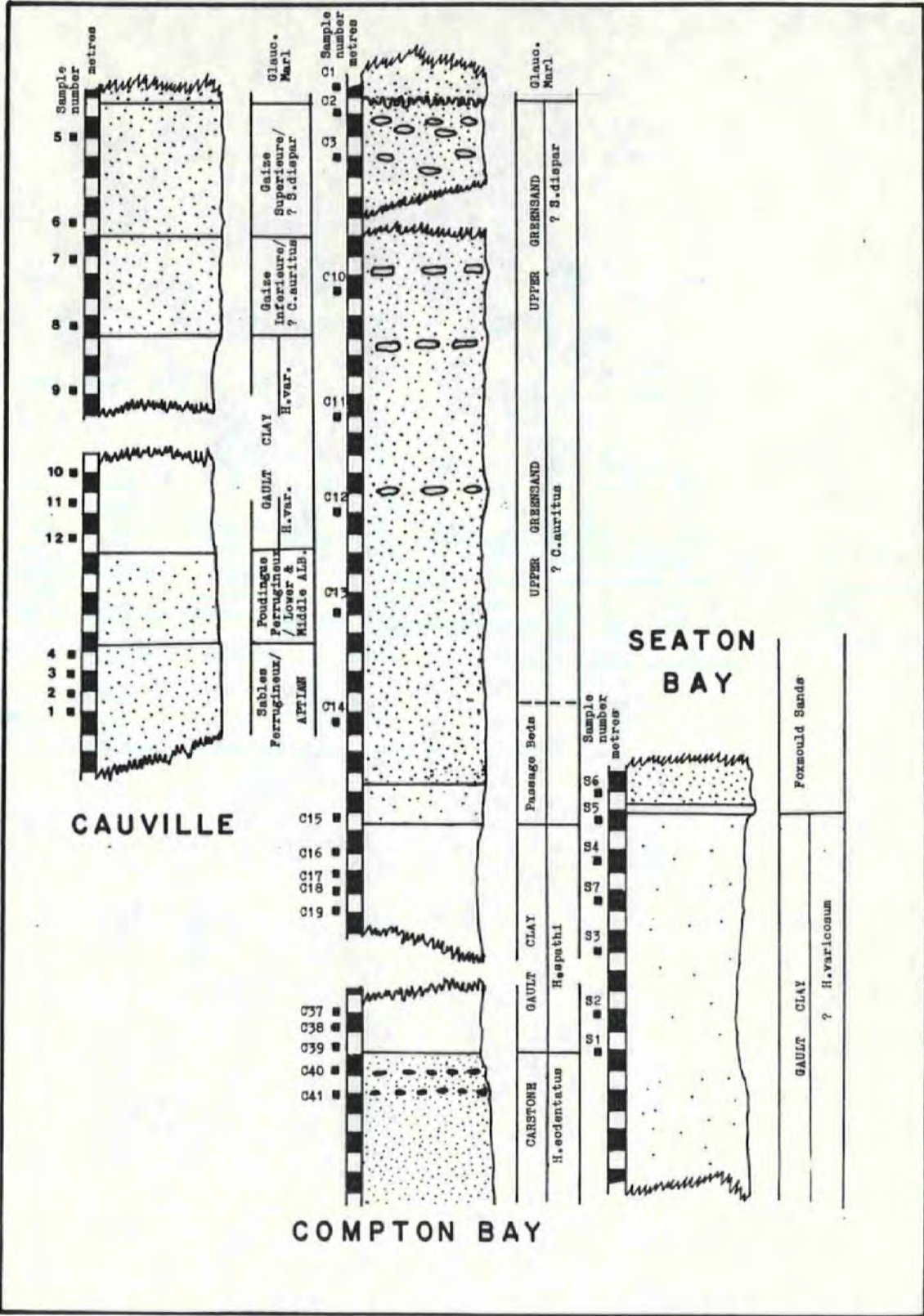
At the site of Morants Court accommodation bridge, adjacent to the motorway route, Owen (pers.comm., 1979) recorded the C.auritus nodule bed. To the north of this borehole, at Chevening Viaduct, he recorded 18 metres of the H.varicosum Subzone. Below this he recorded a 4 metre thickness of the H.orbigny Subzone and a 2 metre thickness of the D.cristatum Subzone. He also stated that the E.nitidus Subzone was recorded less than 60cm. below the base of the D.cristatum Subzone. At Morant's Court the S.dispar Zone was recorded to be at least 25.5 metres thick, however, Owen (pers.comm., 1979) stated that he had not differentiated the M.rostratum and M.perinflatum Subzones.

Compton Bay (SZ 3670 8524) West coast of the Isle of Wight

Nineteen samples were collected from this locality (fig. 3:8).



Fig. 3:8      Lithological logs of the Upper Greensand sections.



The section extends from the Lower Greensand (Carstone) to the 'Glaucinitic Marl' and the Lower Chalk. The Lower Greensand and the Upper Greensand are continuously exposed in this coastal section while the intervening Gault Clay is badly slipped and is discontinuously exposed. The sample collection in the Gault Clay was, therefore, limited to the basal few metres overlying the Lower Greensand and the top few metres which underlie the 'passage beds'.

The Gault Clay and Carstone were studied by Owen (1971a). He concluded that the summit of the Lower Greensand was of H.eodentatus subzonal age and that the basal few metres of the Gault Clay were of L.lyelli subzonal age. Overlying these he recorded 8 metres of the H.spathi Subzone and 5.5 metres of Gault Clay from which he did not obtain a diagnostic macrofauna. This interpretation of the age of the Gault Clay at this locality was followed by Juignet et.al. (1973), but not by Rawson et.al. (1978), who suggested that the Gault Clay spanned the whole of the Middle Albian, and that the Upper Greensand spanned the whole of the Upper Albian. Carter & Hart (1977) recorded the presence of their Zones 5 and 6 in the top half of the Upper Greensand. These Zones are approximately equivalent to the M.inflatum and S.dispar Zones.

The biostratigraphy of this section has remained problematical because of the poor preservation and scarcity of both the macrofauna and the microfauna. No conclusive dates have yet been proposed for the topmost Gault Clay and the basal Upper Greensand. Some indication of the age of the topmost Gault Clay at this locality was gained by Owen (1971a) who recorded that the topmost Gault Clay at Rookley, inland from this locality, extends into the Upper Albian.

Seaton Bay (SY 755 154): fig. 3:8

Seven samples were collected from the silty grey clay which

directly underlies the Foxmould Sands (basal Upper Greensand) and from the base of the Foxmould sands. These were collected essentially to provide comparative material to that described by Kaye from Pinhay, Devon. From the latter locality Kaye described a fauna which included several new species of Ostracoda and which differed markedly from the typical Gault Clay fauna.

Hancock (1969) recorded the A. intermedius Subzone in the basal clay facies at Charlton Goyle, about 5 kilometres to the east of Seaton. He remarked that during this phase of sedimentation, deposition, and probably the sea itself, advanced some 60 kilometres to the West from the Wessex Basin onto the Cornubian massif. Hancock also described the base of the Upper Albian as 'markedly transgressive' and he regarded the Foxmould sands as spanning the H. varicosum and C. auritus Subzones.

The age of both the above mentioned facies is still problematical. These problems have recently been reviewed by Rawson et. al. (1978).

#### Shapwick Grange Quarry (SY 3118 9180), East Devon

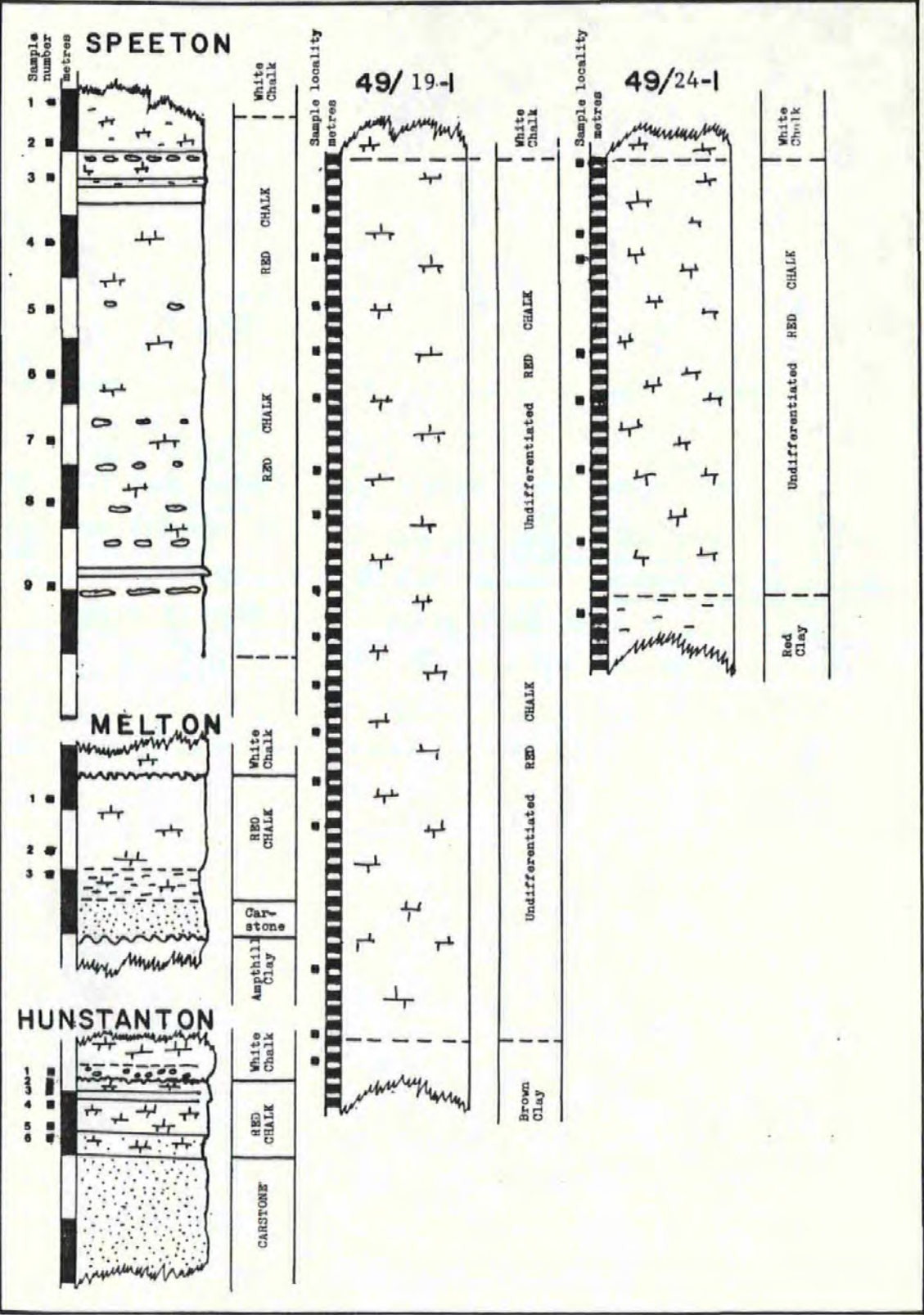
Several samples from the Chert beds/Lower Chalk contact were collected from this locality. This information has been published (Hart, Weaver & Harris, 1979) and is not discussed further in this thesis.

#### Hunstanton (TF 421 675): fig.3:9

Taylor (1823), initially described the 'red rock' of Hunstanton as a separate lithological unit, which he termed the Red Chalk. Subsequently, the macrofauna of this section has been studied by several workers, but the microfauna has only been briefly mentioned by Carter & Hart (1977).



Fig. 3:9 Lithological logs of the southern North Sea Basin sections indicating the distribution of sampling localities.



A total of six samples were collected from this section (fig. 3:9) which is situated directly below the lighthouse at the northeastern end of the Hunstanton sea front. It consists of a thin (1.12 metre) succession of Red Chalk, which is gritty at its base and is underlain by Carstone. One sample was collected from the 'red nodules' at the base of the overlying Cenomanian (Spongia Bed).

Owen (MS.) suggested a macrofaunal zonation for this section. He placed the basal bed of the Red Chalk in the basal A.intermedius or upper H.spathi Subzone. The overlying bed he regarded as of D.cristatum subzonal age and the 'white band' as possibly of C.auritus subzonal age. He ascribed a M.rostratum subzonal age to the topmost bed. Rawson et.al. (1978), regarded the Red Chalk of Norfolk as spanning the entire Middle and Upper Albian and they placed the Carstone in the Lower Albian. Spaeth recorded Neohibolites ernsti Spaeth from the top half of Bed. no. 1 (Spaeth, 1973) which he interpreted as indicative of an Upper Albian (M.inflatum Zone) age.

Melton (SE 272 971): fig.3:9

Three samples were collected from the 'bottom pit' at Melton quarry. This condensed section (fig. 3:8) consists, at its base, of a layer of calcareous nodules which rest on an eroded surface of Ampthill Clay. This layer is overlain by between one and three metres of ferruginous sands (Neale, 1974) which can be divided into two units: the basal greensand (0.3m.), and the overlying Carstone (1m.) which is orange in colour. The top of the Carstone is red and marly and passes gradually into the Red Chalk. Above the Red Chalk the Lower Chalk is present.

This section has been the centre of several palaeontological investigations which have produced largely contradictory results.

Owen et.al. (1968), studied the Brachiopoda of the Carstone and concluded that the population was comparable to that recorded by Casey (1961) from the Shenley Limestone, which Casey regarded as of Lower Albian age. Dilley (1969) studied the foraminifera of the Carstone. He referred to the zonal scheme of Hecht (1938) and concluded that the Carstone is of Lower Albian age. Owen et. al. (1968), also recorded an ammonite, Dimorphoplites cf. hilli from the Red Chalk, which they regarded as indicative of a Middle Albian age. H. G. Owen (pers.comm., 1979) corroborated this conclusion and added that this species is indicative of the E.meandrinus Subzone. He also stated that this ammonite was not found in situ and was "thought" to have originated in the Red Chalk, on the basis of its sediment matrix.

Kaye (1964a) suggested a Middle Albian age for the basal Red Chalk and the uppermost Carstone while Spaeth (1973) regarded the upper part of the Red Chalk as being either of E.lautus or M.inflatum subzonal age.

Speeton (TA 750 166), East Yorkshire: fig. 3:9

From this coastal section a total of eleven samples were collected from a slipped block (?), which was situated approximately 200 metres to the north of the point where the chalk cliffline descends to the level of the beach. Several samples were collected from another slipped block which was situated at H.W.M. approximately 50 metres to the north of the latter block. At this locality a brownish clay was present directly below the Red Chalk. The contact between these two lithological units represents a plane of slippage. These two sections were compared to the lithological sequence recorded by Neale (1974) who regarded most of the Red Chalk as of Upper Albian and/or lowest Cenomanian age, with the underlying clays representing the Lower and Middle Albian. He also indicated that apart from the Belemnoida, the macrofaunal evidence for dating

this section is very limited. The southernmost of the two blocks sampled in this study appears to be lithologically identical to that described by Spaeth (1973) in his study of the genus Neohibolites.

Rawson et.al. (1978), regarded the Red Chalk of this locality as spanning an interval from the topmost M.inflatum Zone to the top of the S.dispar Zone, while Kaye (MS.) sampled the lowest part of the Red Chalk and concluded that it was of Upper Albian age. Kaye regarded the underlying clays as being of Middle Albian age while Rawson et.al. regarded them as of Upper Albian age.

#### Southern North Sea Basin

Samples from two offshore wells were provided for this study by Shell Exploration and Production Ltd. These samples consisted of well cuttings which were mainly composed of white Chalk, Red Chalk, clay, and flint fragments. The samples were picked for microfauna 'downhole' from the first occurrence of Red Chalk fragments.

These samples were from wells in the Indefatigable gas-field approximately 88 kilometres north-east of Great Yarmouth and 23 kilometres north-east of the Leman field (fig. 3:1). This gas-field was discovered in 1966 and three production platforms were located between 1970 and 1972. The Lower Cretaceous has previously been regarded as thin in this area. France (1975) indicated that it was approximately between 50 and 80 metres thick and showed that it occurred at between 800 metres and 1200 metres depth (directly overlying Triassic evaporites). This marked unconformity is generally regarded as being due to the Cimmerian phase of earth movements. France also indicated that the Lower Cretaceous of this area consisted of glauconitic sandstones interbedded with shales.

Rhys (1974) included details of wells 48/22-2 and 49/24-1, while Rawson et.al. (1978) also mentioned well 48/22-2. They concluded

that the Red Chalk from this latter well spanned the Middle and Upper Albian. From this well 29 metres of Red Chalk was recorded and this compares with the c.70 metres and c.90 metres recorded from the wells in the present study. Since block 48 is due west of block 49, these thicknesses may indicate that the Red Chalk thins from the Sole Pit Trough towards the present landmass. Onshore, only the Speeton section has a comparable thickness of Red Chalk.

Borehole 49/19-1 (fig. 3:9)

Sixty-two samples were provided from this well and of these, twenty-eight were examined for microfauna. The first occurrence 'downhole' of Red Chalk was at 2970 feet, where it was pale pink in colour. The first occurrence 'downhole' of clay was at 3310 feet where it appeared similar in character to the topmost part of the Speeton Clay.

Borehole 49/24-1 (fig. 3:9)

Twenty-four samples were provided from this well, of which ten were examined for their microfauna. Red Chalk was first recorded 'downhole' at a depth of 4270 feet while red marl was first recorded at a depth of 4400 feet. This red marl is lithologically similar to that recorded underlying the Red Chalk of Melton, North Humberside.

FRANCE

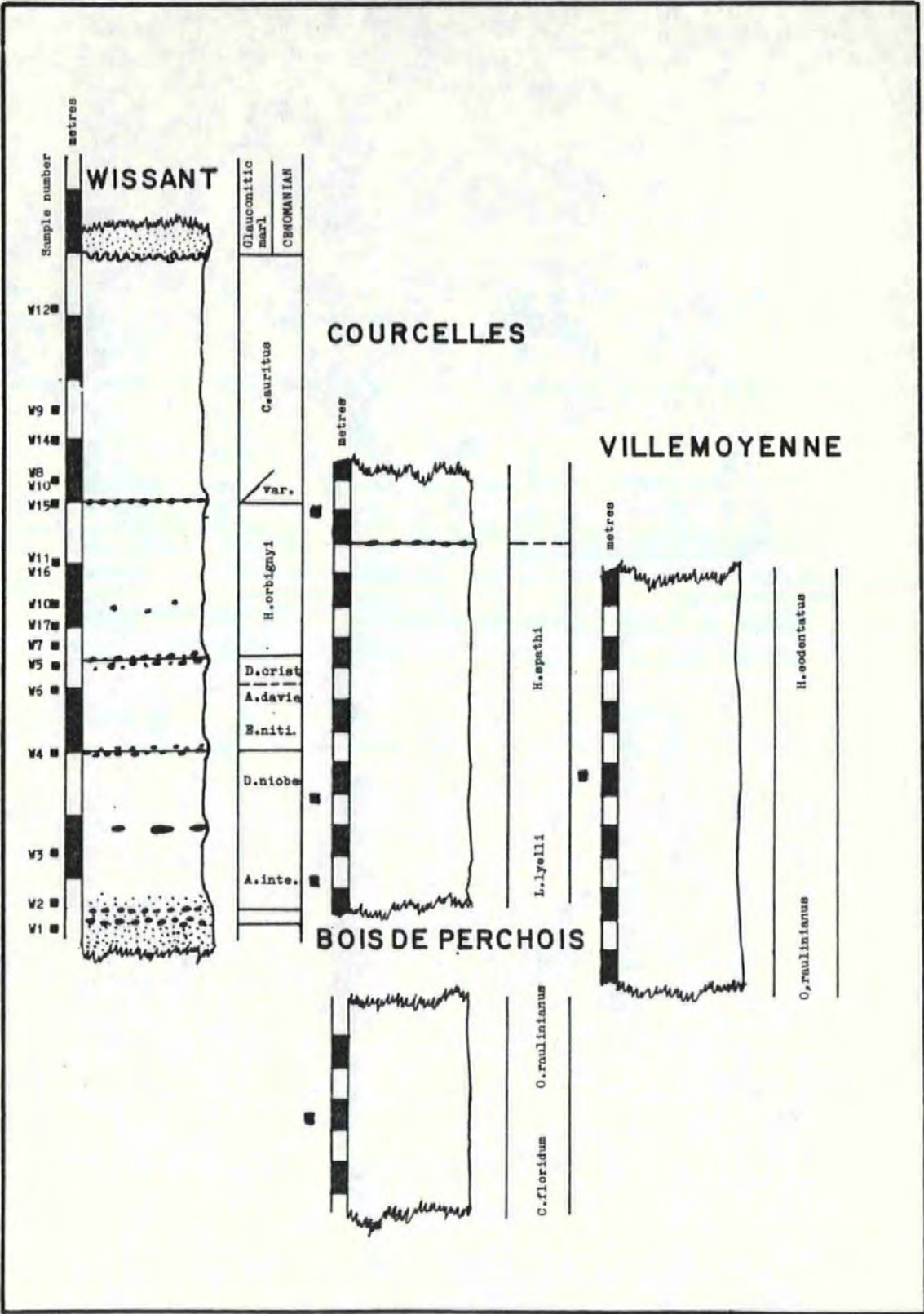
Wissant Petit Blanc Nez, Boulonnais, northwestern France  
(fig. 3:10)

This section is situated on the north French coast just to the southwest of Calais, in the Pas de Boulonnais, on the eastern limb of the Wealden anticline.

Seventeen samples were collected from a number of small localities which stretched from close to the old concrete pillbox, to the south of which the Lower Greensand/Gault contact is visible, to near Petit Blanc Nez (Marie, 1965). The Gault Clay is extensively



Fig. 3:10 Lithological logs of the French Gault Clay localities showing the distribution of sample localities.



slipped along this stretch of coastline and at the time of collection no complete section was visible.

Wissant, like Folkestone, was one of the original localities described by d'Orbigny (1852) in his original definition of the Albion Stage. The Ammonoidea of this section have been studied by Destombes J.P. & P. (1965), Owen (1971a), Juignet et.al. (1973) and Robaszynski et.al. (MS., 1975). All these authors have shown that this succession contains a number of major time gaps, the most significant of which being the complete absence of the S.dispar Zone. The E.loricatus Zone and the H.varicosum Subzone are both very condensed and include major nodule horizons. The interpretation of Owen (1971a) is followed for the D.cristatum Subzone, which he recorded up to 1.5 metres below the D.cristatum nodule bed, and for the A.daviesi Subzone, which he recorded as absent.

The microfauna of this locality has been studied by Marie (1965), Baccaert (1973)., Price (1977b), and Van der Wiel (1978). Robaszynski et.al. produced a detailed range chart of the 'total fauna'. Several of these works were restricted to the study of selected genera and limited stratigraphic intervals.

Cauville Pays de Caux (Seine Maritime), northwestern France  
(fig. 3:10)

This coastal section was collected from the cliffs to the northeast of Le Havre, Pays de Caux which has previously been described by Owen (1971a), Juignet et.al. (1973) and Destombes et.al. (1977). It is situated directly to the north of the stream and consists of the Lower Greensand, Gault Clay, and Upper Greensand. The 'Glaucinitic Marl' and the Lower Chalk are well exposed at the top of the cliff. This section is lithologically similar to that of the Isle of Wight and these two sections have been compared by Owen

(1971a).

Destombes et.al. (1977), showed that the basal Gault Clay was of H.varicosum subzonal age and that this Subzone directly overlaid the D.niobe Subzone of the Middle Albian, which is present in the topmost part of the Poudingue Ferrugineux (Lower Greensand). They recorded that the entire section of Gault Clay and Upper Greensand at this locality was of Upper Albian age and they proved the presence of the C.auritus Subzone and the S.dispar Zone within the Upper Greensand. Both Bignot (1961) and Price (1977b) briefly recorded the Albian foraminifera of Pays de Caux. Bignot (1961) has published a short paper on the Albian foraminifera of the Le Havre area and Price (MS.) recorded the foraminiferal fauna of the Lower Greensand and Gault Clay of the Cauville section. Juignet et.al. (1973) published detailed lithological sections of this area and discussed both the depositional environments and the palaeogeography. This information has been utilised in the reconstruction of palaeogeographic maps for north-western Europe (figs. 1:5 to 1:8).

#### Aube

This district of France was designated the type area of the Albian Stage by d'Orbigny (1852). Comparative samples were collected from several Lower and Middle Albian localities.

In this area the clay facies was deposited as early as the D.mammillatum Zone and these clays overlie a sandy facies of L.tardefurcata zonal age. At the junction between these two lithological units Price (1977b) recorded a major stratigraphic break. The localities of the Aube have been extensively studied by Owen (1971a), Damotte (1971b), Magniez-Jannin (1975) and Price (1977b). The macrofaunal zonation described by Price (1977b) has been followed.

A total of eight samples were collected from the following three localities (fig. 3:9):-

Bois de Perchois    x 726405    y 343610

Courcelles près-Clérey    x 73920    y 5688

Villemoyenne    x 74087    y 5537

#### WEST GERMANY

##### Hannover

Comparative material was collected from two Lower Albian localities to the east of Hannover:-

Vöhrum    4 kilometres northwest of Peine (re 35 78 820,  
h 58 00 000)

Altwarmbüchen    8 kilometres northeast of Hannover (re 35 57 860,  
h 58 12 300)

These sections were recorded by Kemper (1971) to be of L. tardefurcata zonal age. Both these sections consist of clay although coarser, silty, material is present in the clay at Vöhrum. This locality spans the Aptian/Albian boundary.

The sections at Finkenkuhle and Siddinghausen (Price, 1977b) were also visited but were not collected.

The microfauna of all these localities has been thoroughly documented by Bertram & Kemper (1971), Kemper (1973), Kemper et. al. (1975) and Price (1977b). The latter author also studied many sub-surface boreholes from the Hannover area.

## CHAPTER FOUR

### TAXONOMY: FORAMINIFERA

#### Taxonomic Introduction

The classification used in this study is that described in the Treatise on Invertebrate Palaeontology, Part C, Protista 2 (1 & 2), Loeblich & Tappan (1964). The number of species described was limited to those regarded as being of biostratigraphic value by Price (1977b) and Carter & Hart (1977), together with those which occur abundantly in the Albian of northwestern Europe. The Treatise classification has been adhered to simply to maintain taxonomic conformity. Each species has been described and over-splitting has been avoided in order to minimise both taxonomic and biostratigraphic confusion.

A diagnosis and a condensed description of each species has been included and every species has been photographed. The majority of figured specimens have been given specimen numbers and the measurements (m.m.) of each figured specimen have been included. The intra-specific variation of the commoner species has been described in a separate section. The remarks section includes the problems of taxonomy and synonymy, along with the previously recorded distribution and stratigraphic range of the species. The stratigraphic details have been briefly summarised in the stratigraphic conclusion and these have been related to the macrofaunal zonation. The details of range, abundance and the biostratigraphic significance of each species are included in Chapter 8.

Order FORAMINIFERIDA Eichwald, 1830

Suborder TEXTULARIINA Delage & Hérouard, 1896

Superfamily AMMODISCACEA Reuss, 1862

Family AMMODISCIDAE Reuss, 1862

Sub-family AMMODISCINAE Reuss, 1862

Genus Ammodiscus Reuss, 1862

Type species: Ammodiscus infimus Bornemann, 1874

Ammodiscus cretaceus (Reuss, 1845)

(pl. I, figs. 2, 6.)

- 1845 Operculina cretacea Reuss; Reuss: 35, pl. 13, fig. 64  
1860 Cornuspira cretacea (Reuss); Reuss: 177, pl. I, figs. 1a, b  
1863 Cornuspira cretacea (Reuss); Reuss: 34, pl. I, figs. 10a, b  
?1892a Ammodiscus tenuis Brady; Chapman: 326, pl. 6, fig. 12  
1933 Ammodiscus incertus d'Orbigny; Eichenberg: 3, pl. 4, fig. 4  
1934 Ammodiscus cretacea (Reuss); Cushman: 45  
1946 Ammodiscus cretaceus (Reuss); Cushman: 17, pl. I, fig. 35  
1950 Ammodiscus cretacea (Reuss); Ten Dam: 6

Diagnosis: A large species of the genus Ammodiscus with seven to ten whorls.

| Speciman number | Diameter 1 | Diameter 2 | Thickness |
|-----------------|------------|------------|-----------|
| 1               | 0.41 m.m.  | 0.37       | 0.10      |
| 2               | 0.48,      | 0.45       | 0.07      |

Description: Test free; planispiral with aperture at open end of the undivided tubular chamber; chamber gradually increases in size, subrectangular in cross section; test surface smooth.

Remarks: The preservation of this species is very variable. In the Red Chalk many undeformed specimens were found while the majority of specimens from the Lower Albian of Germany were highly deformed, with compressed chambers and distorted outlines.

This species was originally thought to be calcareous by Reuss, but was placed in the genus Ammodiscus by Cushman (1934). His conclusion was based on the examination of type material from Westphalia.

This species occurs throughout the Albian. It occurs most abundantly in the marginal Lower Albian facies of France and Germany where it forms a significant fraction of the fauna. It occurs sporadically throughout the rest of the Albian. The distribution of this species was environmentally controlled during the Albian where it occurs more abundantly in the marginal marine facies.

Stratigraphic conclusion: A long ranging species which occurs throughout the Albian and most of the Cretaceous. It is of limited stratigraphic importance.

Genus Glomospirella Plummer, 1945

Type species: Trochammina squamata Jones & Parker var. gordialis Jones & Parker, 1860

Glomospirella gaultina (Berthelin, 1880)

(pl. I, figs. 3, 7)

1880 Ammodiscus gaultinus Berthelin: 19, pl. I, figs. 3a, b

?1892a Ammodiscus gordialis Jones & Parker: Chapman: 327, pl. 6, fig. 13

1933 Glomospira charoides (Jones & Parker); Eichenberg: 3, pl. 5, fig. 7

1940 Glomospira gaultinus (Berthelin); Tappan: 95, pl. 14, figs. 6a-c

1950 Ammodiscus gaultinus Berthelin; Ten Dam: 7

?1950 Glomospira charoides (Jones & Parker); Ten Dam: 7

1954 Ammodiscus gaultinus Berthelin; Bartenstein: 38, pl. I, figs. 17-20

1967 Glomospira saturniformis Majzon; Fuchs: 260, pl. I, fig. 2

1975 Glomospirella gaultina (Berthelin), Magniez-Jannin: 26, pl. I, figs. 2-4

Diagnosis: A moderately sized species of Glomospirella with the

last two to four whorls planispirally coiled.

|   | Diameter 1 | Diameter 2 | Thickness |
|---|------------|------------|-----------|
| 3 | 0.35m.m.   | 0.32       | 0.19      |
| 4 | 0.33       | 0.23       | 0.13      |

Description: Test free, of moderate size, discoidal or elliptical in umbilical view. The single tubular chamber is initially streptospirally coiled. The last two to four whorls are coiled in the same plane giving the discoidal appearance to the test; test surface finely agglutinated, smooth; chamber compressed in cross section.

Remarks: The confused history of this species illustrates the generic problem of this sub-family which exhibits great variability in the type of coiling. While some specimens are almost completely planispirally coiled others are completely streptospirally coiled. All intermediates between these two forms occur. Previously (e.g. Ten Dam, 1950), authors have separated forms which differ in the type and amount of coiling into separate species and even separate genera. Magniez-Jannin (1975) noted this problem but preferred not to include specimens with different types of coiling in this species. She also stated that the identity of these other forms and their relationship to G.gaultina needs elucidating. In this study all the irregularly coiled specimens have been included in this species. Indeed, with future research, the concept of this species held by Reuss (1863) may be proved to be correct.

Stratigraphic conclusion: A long ranging species which occurs sporadically throughout the Albian. It is of limited stratigraphic importance.



Superfamily LITUOLACEA de Blainville, 1825

Family HORMOSINIDAE Haeckel, 1894

Sub-family HORMOSININAE Haeckel, 1894

Genus Reophax Montfort, 1808

Type species: Reophax scorpiurus Montfort, 1808

Reophax minutus Tappan, 1940

(pl.2,fig.I.)

1892a Hormosina globulifera (non Brady);Chapman:326,pl.6,figs.10a,b

1933 Haplostiche clavulina (non Reuss);Eichenberg:4,pl.I,figs.I,5

1940 Reophax minuta Tappan:94,pl.14,figs.4a,b

1950 Reophax minutus Tappan;Ten Dam:6,pl.I,fig.3

1967 Reophax minutus Tappan;Fuchs:272,pl.I,figs.7,9

Diagnosis: A small, elongate, species of Reophax with four to seven globular chambers.

|   | Length   | Width |
|---|----------|-------|
| 5 | 0.71m.m. | 0.23  |

Description: Test free, uniserial, straight or slightly curved; chambers globular, gradually increasing in size with four to seven per specimen; aperture terminal, rounded, at the end of a distinct tubular neck; sutures moderately depressed. In apertural view the test is circular in outline. In side view the test margins converge slightly towards the umbilicus; greatest width occurs at seven-eighths length.

Remarks: This species was originally figured by Chapman (1892a). The figured specimen was circular in apertural view and was recorded from Bed i at Copt Point. However, the description of this species by Tappan (1940) stated that it is flattened, with all the chambers depressed centrally, or distally, perhaps as a result of compression. Both compressed and uncompressed specimens

were recorded from the Lower Albian of Germany, and from the Red Chalk of eastern England, indicating that the depressed specimens recorded by Tappan (1940) have been compressed. Chapman, Eichenberg (1933) and Ten Dam (1950) all figured specimens with rounded cross sections.

Ten Dam recorded this species commonly from the Albian of Holland and Magniez-Jannin recorded it, occurring sporadically but locally abundant, in the basal Middle to lowest Upper Albian of the Aube. Price (1977b) regarded it as zonally significant and recorded it ranging from the A.intermedius Subzone to the Cenomanian.

Both Gawor-Biedowa (1972) and Magniez-Jannin (1975) have described the variability of this species. Gawor-Biedowa remarked that specimens from Poland differ from the holotype in having a smaller number of chambers and in being half the size. Magniez-Jannin showed that the size of the populations of this species were modified during the Albian.

Stratigraphic conclusion: This species occurs sporadically throughout the Albian and is not of zonal significance.

Sub-family CRIBRATININAE Loeblich & Tappan, 1964

Genus Cribratina Sample, 1932

Type species: Nodosaria texana Conrad in Emery, 1857

Cribratina cylindracea (Chapman, 1892)

(pl.3,fig.16)

1892a Reophax cylindracea Chapman:321,pl.5,figs.7a,b

1961 Haplostiche annulata (non Perner);Bignot: 14,pl.I,figs.Ia,b

1975 Cribratina cylindracea (Chapman);Magniez-Jannin:29,pl.I,fig.7

Diagnosis: An extremely large, elongate, species of Cribratina.

|   | Diameter | Length |
|---|----------|--------|
| 6 | 3.65m.m. | 0.23   |

Description: A large, elongate species; test uniserial; chambers inflated, gradually increasing in size; sutures moderately straight, depressed; aperture single or multiple, terminal. In apertural view test circular; in cross section chambers circular; in side view margins sub-parallel, weakly converging towards a blunt umbilical margin. Wall coarsely agglutinated. Greatest width at mid-length or above.

Variation: The main variation is in the nature of the aperture which may be single or multiple. The size of specimens and the degree of depression of the sutures are also variable.

Remarks: This species was originally described by Chapman (1892a) from Copt Point. He figured a broken specimen and stated that "the specimens were always found in a fragmentary condition". He recorded it as common in Bed X. Bignot (1961) recorded it from the Albian clay of Le Havre while Magniez-Jannin recorded it from the middle Upper and uppermost Upper Albian and Vraconian of the Aube.

The generic status of this species is uncertain. Specimens with both multiple and single apertures were recorded in the same populations and thus this species might be placed in either Cribratina or Haplostiche Reuss, 1861. The morphological similarity, excluding the nature of the aperture, to the type figure of Cribratina (C. texana; in Loeblich & Tappan, Treatise) is greater than that to the type figure of the genus Haplostiche, and thus this species has been assigned to the genus Cribratina.

Stratigraphic conclusion: A rare species which occurs from the H. varicosum Subzone to the Cenomanian. Of limited stratigraphic value.

Family LITUOLIDAE de Blainville, 1825

Sub-family HAPLOPHRAGMOIDINAE Maync, 1952

Genus Haplophragmoides Cushman, 1910

Type species: Nonionina canariensis d'Orbigny, 1839

Haplophragmoides chapmani Morozova, 1948

(pl.2, figs. 8, 9, 11, 14.)

- 1892a Haplophragmium latidorsatum Bornemann; Chapman: 323, pl. 5, figs. 12a, b
- 1933 Haplophragmoides latidorsatum (Bornemann); Eichenberg: 20, pl. I, figs. 7a, b. (?8a, b.)
- 1948 Haplophragmoides chapmani Morozova: 33, pl. I, figs. 2 a-d
- 1950 Haplophragmoides cf. latidorsata (Bornemann); Ten Dam: 9, pl. I, fig. 6
- 1967 Haplophragmoides latidorsatus (Bornemann); Fuchs: 264, pl. 2, figs. 2a-c
- 1975 Haplophragmoides chapmani Morozova; Magniez-Jannin: 37, pl. 2, figs. I-4

Diagnosis: A sub-globose species of Haplophragmoides.

|    | Diameter 1 | Diameter 2 | Width |
|----|------------|------------|-------|
| 7a | 0.53m.m.   | 0.47       | 0.41  |
| 7b | 0.52       | 0.47       | 0.36  |
| 8a | 0.44       | 0.40       | 0.34  |
| 8b | 0.40       | 0.33       | 0.22  |

Description: Test free, planispiral, involute, with five to six chambers in the last whorl; sutures limbate, slightly depressed; aperture an equatorial interiomarginal slit, apertural face flat, weakly convex; chambers in last whorl gradually increase in size; wall coarsely agglutinated; chambers sub-ovate in cross section; in apertural view last chamber slightly higher than earlier chambers; diameter twice the maximum height.

Remarks: This species was originally figured by Chapman (1892a) as H. latidorsatum and was recorded by him throughout the Gault Clay at Folkestone but only in abundance in the top half of the S. dispar Zone. Subsequently this species was recorded from the

Albian of France and Germany.

This species has a similar range to H. nonioninoides. When these two species occur in the same sample they are often morphologically gradational and are difficult to separate. Magniez-Jannin (1975) also noted that this species is closely related to H. nonioninoides. She postulated the evolution of H. chapmani from the latter in the uppermost Albian.

This species often occurs in a deformed state and these deformed specimens have often been included in separate species or even genera.

Stratigraphic conclusion: A long ranging species which occurs throughout the Albian, but more commonly in the Upper Albian. It is of limited stratigraphic value.

Haplophragmoides nonioninoides (Reuss, 1863)

(pl. 3, fig. I.)

1863 Haplophragmium nonioninoides Reuss: 30, pl. I, figs. 8a, b

1880 Haplophragmium nonioninoides Reuss; Berthelin: 21

1892a Haplophragmium nonioninoides Reuss; Chapman: 321, pl. 5, figs. 9a, b

1892a Haplophragmium acutidorsatum Hantken; Chapman: 322, pl. 5, figs.

11a-c

1954 Haplophragmoides nonioninoides (Reuss); Bartenstein: 38

1975 Haplophragmoides nonioninoides (Reuss); Magniez-Jannin: 30, pl. 2, figs. 9-18; text figs. 11, 12

Diagnosis: A large, compressed, species of Haplophragmoides.

|   | Diameter 1 | Diameter 2 | Thickness |
|---|------------|------------|-----------|
| 9 | 0.87m.m.   | 0.80       | 0.35      |

Description: Test free, planispiral, involute, with six to fourteen chambers in the last whorl; sutures limbate, slightly depressed; aperture an equatorial interiomarginal slit, apertural face weakly convex; chambers increase gradually in size. In

apertural view the last formed chamber appears subtriangular and slightly higher than previous chambers; diameter of test approximately three times the height.

Remarks: This species was first described by Reuss (1863) from the Albian of Germany and was subsequently recorded from France, by Berthelin (1880), and from England by Chapman (1892a). Chapman also figured a compressed specimen (H. acutidorsatum). Chapman recorded this species throughout the Gault Clay at Folkestone. Magniez-Jannin (1975) has published a very thorough study of the evolution of this species. She described the variation in size, outline, and the number of chambers of this species throughout the Albian. She separated it into two forms, one typical of the Lower Albian the other of the uppermost Albian.

This species differs from H. chapmani Morozova, 1948 by being less high with more chambers in the last whorl which is also less involute. In apertural view the last chamber is sub-triangular, and not ovate.

Stratigraphic conclusion: A long ranging species which occurs commonly throughout the Albian. It is of limited stratigraphic value.

Family TEXTULARIIDAE Ehrenberg, 1838

Sub-family TEXTULARIINAE Ehrenberg, 1838

Genus Textularia Defrance in de Blainville, 1824

Type species: Textularia sagittula Defrance in de Blainville, 1824

Textularia anceps Reuss, 1845

(pl.3, fig.14)

1845 Textularia anceps Reuss:39, pl.8, figs.79a,b, pl.13, figs.

78a,b

1845 Textularia praelonga Reuss:39, pl.12, figs.14a-c

- 1860 Textularia anceps Reuss; Reuss: 234, pl. 13, figs. 2a, b  
 1860 Textularia praelonga Reuss; Reuss: 234  
 1892a Textularia praelonga Reuss; Chapman: 329, pl. 6, fig. 23  
 1892b Spiroplecta anceps (Reuss); Chapman: 751, pl. 11, fig. 6  
 1892b Spiroplecta praelonga (Reuss); Chapman: 751, pl. 11, fig. 5  
 1972 Spiroplectamina praelonga (Reuss); Gawor-Biedowa: 18, pl. I, fig. I  
 1975 Textularia anceps (Reuss); Magniez-Jannin: 52, pl. 3, figs. 20-23

Diagnosis: A compressed species of Textularia with narrow test margins.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 10 | 0.48m.m. | 0.20  | 0.10      |

Description: Test free, biserial, with eleven to fifteen chambers; last formed chambers of equal size, early chambers increase slowly in size, sutures very weakly depressed, aperture not observed; in apertural view test sub-ovate, margins sharp; in side view test elongate, margins sub-parallel, weakly tapering towards the pointed umbilical margin; test compressed in plane of biseriality; test surface finely agglutinated, smooth; greatest width at mid-length.

Remarks: This species was originally described by Reuss (1845) as two separate species. Magniez-Jannin (1975) was the first to recognise these as end members of a gradational series and she included both in the same species. T.anceps was the first to be described and this name, therefore, takes precedence. Chapman (1892a) recorded this species from Bed XI at Folkestone while Magniez-Jannin recorded it in the uppermost Albian and Vraconian of the Aube. Gawor-Biedowa (1972) recorded it from the uppermost Albian, Cenomanian and Turonian of Poland. Price (MS.) did not record it.

Magniez-Jannin showed that this species varies greatly in the rate of increase in size, height and width of the chambers.



Stratigraphic conclusion: This species occurs very rarely in the uppermost Albian and is of limited stratigraphic value.

Textularia chapmani Lalicker, 1935

(pl.2,figs.5,6,7,)

- 1892a Textularia conica non d'Orbigny;Chapman:329,pl.6,fig.20  
1935 Textularia chapmani Lalicker:13,pl.2,figs.8a-c,9  
1950 Textularia chapmani Lalicker;Ten Dam:11,pl.I,fig.10  
1967 Textularia chapmani Lalicker;Fuchs:267,pl.3,fig.3  
1972 Textularia chapmani Lalicker;Gawor-Biedowa:19,pl.1,figs.2a,b  
1975 Textularia chapmani Lalicker;Magniez-Jannin:54,pl.3,figs.1-9

Diagnosis: A medium sized species of Textularia, the chambers of which increase rapidly in size.

|     | Length   | Width | Thickness |
|-----|----------|-------|-----------|
| 11a | 0.45m.m. | 0.32  | 0.23      |
| 11b | 0.47     | 0.40  |           |

Description: Test free, biserial, with chambers rapidly increasing in size, eleven to fifteen in number; last chamber large and inflated; aperture an interiomarginal slit; sutures moderately depressed. In apertural view the test is sub-ovate in outline, in side view test subtriangular, margins straight, slightly irregular, strongly tapering towards a pointed umbilicus; moderately compressed in place of biseriality; wall agglutinated, surface almost smooth, finely agglutinated; greatest width at apertural end.

Variation: This species has a smoother test surface and is more inflated in the uppermost Albian than in the lowest Upper Albian.

Remarks: This species was originally described by Chapman (1892a). He recorded the figured specimen from Bed XI of the Gault Clay at Folkestone but referred it to a recent species described by d'Orbigny. Ten Dam (1950) and Fuchs (1967) recorded it from the

Albian of Holland and Magniez-Jannin (1975) recorded it rarely in the lower Upper Albian and commonly in the uppermost Albian and Vraconian of the Aube.

Walters (MS.) regarded it as "quite characteristic of the Upper Gault" while Price (1977b) regarded this as a zonally significant species which occurs from the H. varicosum Subzone upwards.

Stratigraphic conclusion: A common species which typically occurs in the Upper Albian, becoming more abundant in the H. varicosum Subzone. It also occurs in the Middle Albian and Cenomanian.

Textularia minuta Berthelin, 1880

(pl.2, fig.2.)

- 1863 Textularia pygmaea Reuss:80, pl.9, figs. 2a,b  
1880 Textularia minuta Berthelin:26  
?1892a Textularia minuta Berthelin;Chapman:327, pl.6, fig.15  
1954 Textularia minuta Berthelin;Bartenstein:39  
1975 Textularia minuta Berthelin;Magniez-Jannin:49, pl.3, figs.35,36

Diagnosis: A small species of Textularia.

|    | Length   | Width |
|----|----------|-------|
| 12 | 0.35m.m. | 0.17  |

Description: Test free, elongate, biserial, increasing slowly in size; greatest width at five sixths length; sutures weakly depressed; aperture a low arch at the base of the last chamber; wall agglutinated, test surface finely agglutinated.

Remarks: This species has a confused history. It was originally recorded by Reuss (1863) as T. pygmaea. Following this,

Berthelin (1880) renamed it T.minuta and this name has been followed by all subsequent authors and is followed here. However, neither Berthelin nor Bartenstein (1954) figured this species and Chapman (1892a) although figuring it, did not give a description. He recorded it as frequent to very common at Folkestone from Bed iii upwards. This abundance and range is in direct contradiction to that recorded by Price (1977b) who recorded this species occurring rarely in the Lower Albian and in the H.dentatus Zone. Magniez-Jannin (1975) recorded it as occurring sporadically throughout the Albian. All these ranges are in direct contradiction, indicating that if this species has been consistently recognised it must be of very variable abundance and range. In the present study it was recorded very rarely in the Middle and Upper Albian of the Anglo-Paris Basin.

Both Chapman (1892a) and Magniez-Jannin (1975) noted the variation of this species. Chapman noted that the specimens from the uppermost portion of Bed xi are larger and more attenuated. Magniez-Jannin recorded an increase in size of specimens during the Albian, and noted that the specimens from the Aube are coarsely agglutinated, while those figured by both Reuss from North Germany and Chapman from Folkestone are finely agglutinated.

Stratigraphic conclusion: Normally a rare species that occurs sporadically during the Middle and Upper Albian. It is of limited stratigraphic importance.

Textularia sp. A.sp.nov.

(pl.3, figs. 7,8.)

Diagnosis: A large species of the genus Textularia with sub-parallel margins.

|    | Length   | Width |
|----|----------|-------|
| 13 | 0.71m.m. | 0.26  |
| 14 | 0.61     | 0.22  |

Description: Test free, elongate, biserial, increasing slowly in size, chambers inflated; greatest width at apertural end, margins subparallel; aperture a low interiomarginal arch at the base of the last chamber; wall agglutinated; test surface finely agglutinated.

Remarks: A distinctive species which is longer and less wide than the other Albian species of this genus. It has only been recorded in abundance from the Albian of the southern North Sea and Saxony basins.

Stratigraphic conclusion: This species has only been recorded abundantly from the Lower Albian of the 'Boreal realm'. It is of limited stratigraphic significance.

Family ATAXOPHRAGMIIDAE Schwager, 1877

Sub-family VERNEULLININAE Cushman, 1911

Genus Belorussiella Akimez, 1958

Type species: Belorussiella bolivinaeformis Akimez, 1958

Belorussiella textilarioides (Reuss, 1863)

(pl.2, fig.13.)

1863 Bolivina textilarioides Reuss:81, pl.10, figs.1a,b

1880 Bolivina textilarioides Reuss; Berthelin:28, pl.1, figs.5a-c

1892b Bolivina textilarioides Reuss; Chapman:757, pl.12, figs.12a,b

1940 Bolivina cf. textilarioides Reuss; Tappan:111, pl.18, figs.8a-c

1972 Bolivina textilarioides Reuss; Gawor-Biedowa:55, pl.5, figs.6a,b

1975 Belorussiella textilarioides (Reuss); Magniez-Jannin:64, pl.5,  
figs.8-14, text fig.23

Diagnosis: A moderately sized species of Belorussiella with subparallel test margins.

|    | Length   | Width |
|----|----------|-------|
| 15 | 0.48m.m. | 0.16  |

Description: Test free, elongate; initial chambers triserial, later ones more inflated and biserial with eleven to sixteen chambers in the biserial portion; biserial portion oval in cross section; last chamber forms a weak point anteriorally. The aperture consists of an elongate loop shaped slit which is wider near the chamber apex and which extends up the face of the final chamber to the apex; wall agglutinated; surface has sugary appearance; greatest width at two thirds to five sixths length; in side view the test margins taper towards the posterior margin, more rapidly so towards the posterior extremity giving a slightly convex appearance to the margins.

Remarks: This species was originally recorded from the Albian of North Germany. Subsequently it has been recorded from much of northwestern Europe and from North America. It was placed in the genus Belorussiella by Magniez-Jannin (1975) because of the agglutinated nature of its wall. She also described the morphological variation exhibited by this species and recorded it as of variable abundance in the basal Middle to lowest Upper Albian of the Aube.

Stratigraphic Conclusion: This species ranges from the H.spathi Subzone to the H.orbignyi Subzone but occurs most consistently and abundantly in the A.intermedius Subzone. It was only recorded from the Anglo-Paris Basin where it is regarded as of zonal significance.

Genus Flourensina Marie, 1938

Type species: Flourensina douvillei Marie, 1938

Flourensina intermedia Ten Dam, 1950

(pl.5, figs.1,5,6,7.)

1950 Flourensina intermedia Ten Dam:15, pl.1, fig.16

1977a Flourensina intermedia Ten Dam; Price:508, pl.59, figs.1,2

fig.2

Diagnosis: A large, coarsely agglutinated, species of Flourensina which is triangular in cross section.

|     | Length   | Width |
|-----|----------|-------|
| 16  | 1.17m.m. | 0.8   |
| 17a | 0.76     | 0.51  |
| 17b | 0.94     | 0.53  |

Description: Test free; chambers arranged trochospirally, triserial, test triangular in cross section; apertural face weakly obtuse; aperture an interiomarginal loop situated in a slight depression in the apertural face; last chamber embraces two thirds to three quarters of the test circumference; chambers inflated; sutures strongly depressed; sutures appear irregular due to coarse agglutination. In side view the test margins are straight but irregular due to the coarse agglutination; in apertural view last chamber appears circular; margins converge strongly towards the umbilicus, umbilical margin bluntly pointed; greatest width at five sixths length.

Variation: This species varies from weakly triangulate to very strongly triangulate.

Remarks: This distinctive species was first recorded by Ten Dam (1950) from the Upper Albian of Holland and has subsequently been discussed thoroughly by both Price (1977a) and Carter & Hart (1977). Carter & Hart recorded it as a variable species which occurs fully developed in their Zone 6A with rare, very small, atypical specimens in the lower part of Zone 5a. They also suggested an evolutionary sequence from A.sabulosa (Chapman, 1893) to F.intermedia. Price also recorded this species from the uppermost part of the S.dispar Zone. However, he did not agree with the evolutionary sequence



postulated by Carter & Hart and instead suggested that this species evolved from the triserial A.frankei (Cushman, 1936). Price thought that the ubiquitous occurrence of F.intermedia, when compared to the localised occurrence of A.sabulosa, was sufficient proof of this. However, intermediate specimens between these two species were recorded in the present study from several southern England localities of M.perinflatum subzonal age. These specimens prove the evolutionary sequence of Carter & Hart to be correct. This sequence involves a change from a coarsely agglutinated and quadriserial A.sabulosa, to specimens with sub-quadrate and sub-triangular cross sections, and eventually specimens with a strongly triangular cross section. Although specimens of A.frankei were recorded from the S.dispar Zone of the southern North Sea Basin no specimens of F.intermedia were recorded and hence there is no evidence to suggest that this species evolved from A.frankei.

Stratigraphic conclusion: This species was only recorded from Zones Fii and Fiii with typical specimens of F.intermedia only being recorded from Fiii. The areal distribution of this species has not been fully ascertained but it is a very important zonal marker in the Anglo-Paris Basin.

Genus Gaudryina d'Orbigny in De La Sagra, 1839

Type species: Gaudryina rugosa d'Orbigny, 1840

D.bulletta (Carsey, 1926) was erected by Plummer, 1931 as the type species of the genus Dorothia. It differs greatly from the type species of Gaudryina (in: Loeblich & Tappan, Treatise C269) which has an initial triserial and commonly triangular stage. In contrast, D.bulletta, has an early trochoid portion which is circular in cross

section (see also Dorothia).

Gaudryina filiformis Berthelin, 1880

(pl.2, figs.3,4.)

- 1880 Gaudryina filiformis Berthelin:25,pl.I,figs.8a-d  
1892b Gaudryina filiformis Berthelin;Chapman:752,pl.11,fig.7  
1937a Dorothia filiformis (Berthelin);Cushman:73,pl.8,figs.I,2  
1950 Dorothia filiformis (Berthelin);Ten Dam:16  
1954 Dorothia filiformis (Berthelin);Bartenstein:39,pl.I,figs.14,15  
1967 Dorothia filiformis (Berthelin);Fuchs:273,pl.4,fig.4  
1975 Dorothia filiformis (Berthelin);Magniez-Jannin:83,pl.8,figs.  
1,2;text fig. 34  
1977 Dorothia filiformis (Berthelin);Carter & Hart:7,pl.I,fig.3

Diagnosis: A thin, elongate, species of Gaudryina with a triserial and sub-triangular initial portion.

|    | Length   | Height | Width |
|----|----------|--------|-------|
| 20 | 0.56m.m. | 0.15   | 0.13  |
| 21 | 0.41     | 0.14   | 0.12  |

Description: A moderately sized species of Gaudryina; test free, narrow, elongate with the initial few chambers arranged triserially; test quickly becomes biserial with ten to sixteen chambers in the biserial portion; sub-ovate in cross section; apex of last chamber rounded; aperture an interiomarginal slit. The chambers appear rounded with distinctly depressed sutures; test margins uneven, sub-parallel, weakly converging towards the umbilicus, umbilicus bluntly pointed; test wall agglutinated, surface moderately coarsely grained; greatest width near anterior end.

Remarks: This species was originally described by Berthelin (1880) from the Gault of Montcley. Chapman (1892b) recorded it as

well distributed throughout the Gault Clay at Folkestone. Subsequent authors placed this species in the genus Dorothia although Walters (MS.) retained it in the genus Gaudryina.

Magniez-Jannin (1975) recorded it throughout the Albian of the Aube, although she noted that it occurred more commonly in the Lower and Middle Albian. Carter & Hart (1977) regarded this species as of zonal significance and recorded it ranging through the Middle and Upper Albian, occurring most commonly in their Zones 3-5a, but generally rare with only a scattered distribution in Zone 6. Price (MS.) did not regard it as zonally significant, and recorded it as ranging throughout the Albian of northwestern Europe.

Stratigraphic conclusion: A common species which ranges throughout the Albian and occurs ubiquitously across northwestern Europe. It is of variable abundance and is of only very local stratigraphic importance.

Gaudryina gradata Berthelin, 1880

(pl.3,figs.9,15.)

- 1880 Gaudryina gradata Berthelin:24,pl.I,figs.6a-c  
1880 Gaudryina spissa Berthelin:24,pl.I,figs.7a-d  
1890 Gaudryina pupoides non d'Orbigny;Burrows et. al.:554,pl.8,fig.22  
1892b Gaudryina pupoides non d'Orbigny;Chapman:752,pl.2 ,figs.8a,b  
1892b Gaudryina dispansa Chapman:753,pl.11,figs.10a,b  
1892b Textularia agglutinans non d'Orbigny;Chapman:754,pl.11,fig.21  
1931 Gaudryina gradata Berthelin;Plummer:136,pl.8,fig.12  
1937a Dorothia gradata (Berthelin);Cushman:74,pl.8,figs.3-5  
1950 Dorothia gradata (Berthelin);Ten Dam:16  
1954 Dorothia gradata (Berthelin);Bartenstein:39  
1972 Dorothia gradata (Berthelin);Gawor-Biedowa:29,pl.2,figs.7a,b  
1975 Dorothia gradata (Berthelin);Magniez-Jannin:86,pl.8,figs3-6,  
text.fig.38

Diagnosis: A large species of Gaudryina with inflated chambers and sub-parallel test margins.

|    | Length   | Width |
|----|----------|-------|
| 18 | 0.43m.m. | 0.27  |
| 19 | 0.52     | 0.21  |

Description: Test free, elongate, inflated; initial chambers triserial, majority of test biserial, biserial portion of test consists of 6 to 13 chambers; sub-rectangular in cross section; last chamber rounded at apex; aperture an interiomarginal slit; sutures depressed giving an undulating appearance to the test margins; margins sub-parallel anteriorly converging more strongly towards the umbilicus; wall agglutinated, test surface moderately coarsely grained; greatest width between one half and seven eighths length.

Remarks: This species was originally described by Berthelin (1880) from the Gault Clay of Montcley as two separate species. This confusion was further compounded by Chapman who included specimens of this species in two genera and five species. Of these, G.dispansa Chapman is merely a deformed specimen of G.gradata.

Cushman, (1973a) placed this species in the genus Dorothia. However, Plummer (1931) in her diagnosis of the genus Dorothia retained this species in the genus Gaudryina. Walters (MS.) also included this species in the genus Gaudryina.

Stratigraphic conclusion: This species has been recorded commonly throughout the Albian and Cenomanian of northwest Europe. It is of limited stratigraphic importance.

Genus Spiroplectinata Cushman, 1927

Type species: Textularia annectens Parker & Jones, 1863

Spiroplectinata annectens (Parker & Jones, 1863)

(pl.3, figs.11-13.)

- 1863 Textularia annectens Parker & Jones:92,fig.I
- 1890 Textularia complanata Reuss;Burrows et. al. :553,pl.8,fig,16.
- 1892b Spiroplecta annectens Parker & Jones;Chapman:750,pl. 11,figs.  
3a,b  
o
- 1892b Spiroplecta complanata (Reuss);Chapman:751,pl. 11,fig.4
- 1898 Textularia complanata Reuss;Chapman:13,pl.2,fig.7
- 1937a Spiroplectinata annectens (Parker & Jones);Cushman:101,pl.14,  
figs.10-12
- 1950 Spiroplectinata annectens (Parker & Jones);Ten Dam:13,pl. I,  
figs.13,14
- 1967 Spiroplectinata annectens (Parker & Jones);Fuchs:269,pl.3,fig.I
- 1967 Spiroplectinata Bettenstaedti Grabert;Fuchs:271,pl.3,fig.5
- 1967 Spiroplectinata complanata (Reuss);Fuchs:271,pl.4,fig.9
- 1972 Spiroplectinata annectens (Parker & Jones);Gawor-Biedowa:23,  
pl. I,fig.8
- 1972 Spiroplectinata complanata (Reuss);Gawor-Biedowa.24,pl. I,fig.9
- 1975 Spiroplectinata annectens (Parker & Jones);Magniez-Jannin:69,  
pl.5,figs.23-24

Diagnosis: A moderately sized, compressed, species of  
Spiroplectinata.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 22 | 1.22m.m. | 0.31  | 0.14      |
| 23 | 0.67     | 0.20  | 0.12      |
| 24 | 0.91     | 0.42  |           |

Description: Test free, triserial in its initial portion,  
biserial for the majority of the test and finally uniserial;  
sutures weakly depressed in initial portion, strongly constricted in  
uniserial portion; in side view margins sinuous, tapering weakly  
towards the umbilicus; greatest width at approximately five sixths

length; aperture round in microspheric form, a crescentic slit in macrospheric form; uniserial portion rounded, biserial portion sub-rectangular, flattened; wall finely agglutinated. The microspheric forms are smaller with a distinct uniserial portion; the macrospheric forms are larger and lack the uniserial portion.

Remarks: This species was originally described from the Gault Clay of southeast England by Parker & Jones (1863). Chapman (1892b) recognised both this species and one described by Reuss; S.complanata. He recorded both forms from Bed V upwards at Folkestone but noted that the Folkestone specimens had only two chambers in the uniserial portion while those from Biggleswade had as many as four. This species was also recorded from the Red Chalk by Burrows et.al.(1890). They recorded that their specimens differed to the type specimens figured by Reuss in being shorter and broader with fewer chambers. These early works illustrate the variability of this species. This variability has subsequently been regarded as being partially due to the presence of microspheric and megalospheric generations, S.annectens representing the microspheric generation, and S.complanata representing the macrospheric generation. Many authors have regarded these different generations as separate species, however, the present author prefers to follow the works of Ten Dam (1950), Magniez-Jannin (1975) and Hart (MS.) in regarding them as a single species. Price has suggested the possibility of a third generation and this view has been endorsed by the present study.

This species is very variable in both the size and number of chambers in each generation. This variability is probably due to environmental control (Price, MS.). Price (1977b) also regarded this species as of zonal significance. He recorded it ranging throughout the Albian, but in far greater abundance in the M.inflatum Zone. This species was recorded by Price as occurring ubiquitously



across northwest Europe. In the present study it was recorded sporadically throughout the Albian.

Stratigraphic conclusion: A common species which occurs sporadically throughout the Albian. It is more abundant in the Upper Albian but is only of limited stratigraphic significance.

Genus Tritaxia Reuss, 1860

Type species: Textularia tricarinata Reuss, 1844

Tritaxia pyramidata Reuss, 1863

(pl.3, figs.2,3,10.)

- 1863 Tritaxia pyramidata Reuss:32, pl. I, figs.9a-c
- 1880 Tritaxia pyramidata Reuss; Berthelin:25, pl. I, figs.4a-c
- 1892b Tritaxia pyramidata Reuss; Chapman:750, pl. 12, figs.2a-b
- 1892b Tritaxia tricarinata non Reuss; Chapman:749, pl. 12, figs.1a,b
- 1937a Tritaxia pyramidata Reuss; Cushman:22, pl. 2, figs.21-24a,b; pl. 3, figs.1-8
- 1950 Tritaxia pyramidata Reuss; Ten Dam:12
- 1953 Tritaxia pyramidata Reuss; Barnard & Banner:195, pl. 7, figs.1a,b, text figs.5J-N
- 1954 Tritaxia pyramidata Reuss; Bartenstein:39
- 1967 Verneulina variabilis Brady; Fuchs:269, pl. 3, fig.2
- 1972 Tritaxia pyramidata Reuss; Gawor-Biedowa:27, pl. I, figs.10a,b
- 1975 Tritaxia pyramidata Reuss; Magniez-Jannin:71, pl. 5, figs.25-28
- ?1975 Tritaxia singularis Magniez-Jannin:75, pl. 5, figs.39-41
- 1977 Tritaxia pyramidata Reuss; Carter & Hart:13, pl. 2, fig.15

Diagnosis: A large species of the genus Tritaxia with slightly concave sides.

|     | Length   | Width 1 | Width 2 |
|-----|----------|---------|---------|
| 25  | 1.85m.m. | 1.00    | 0.67    |
| 26a | 1.30     | 0.78    | 0.25    |
| 26b | 0.44     | 0.37    |         |

Description: Test free, triserial in early portions, triangular in cross section; last chamber uniserial; sides slightly concave; sub-triangular in side view; sutures straight, difficult to observe, generally flush to test surface; sutures form a 'v' shape which is pointed towards the apertural end; aperture terminal; last chamber circular in apertural view; greatest width at five sixths length; wall coarsely agglutinated.

Variation: This species varies greatly in size becoming larger in the topmost Albian. Middle Albian specimens tend to incorporate coarser grains into their test wall, and have a rougher test surface than Upper Albian specimens. The concavity of the test sides and the orientation of the sutures also varies (Magniez-Jannin, (1975).

Remarks: This species was originally figured by Reuss from Germany where he recorded it from the Albian to the Senonian. Subsequently it has been recorded from the Gault Clay of Montcley by Berthelin (1880) and by Chapman (1892b) who recorded it in Beds v to xi at Folkestone. Chapman described it as "this somewhat wild growing form". Both Barnard & Banner (1953) and Carter & Hart (1975) recorded it ranging through the Albian of the Aube. Magniez-Jannin (1975) noted that it was rare in the Lower Albian. Price (1977b) did not regard this as a zonally significant species and recorded it ranging from the H.eodentatus Subzone to the topmost Albian.

Stratigraphic conclusion: This species occurs abundantly throughout the Albian. It is of limited stratigraphic value.

Genus Uvigerinammia Majzon, 1943

Type species: Uvigerinammia jankoi Majzon, 1943

Uvigerinammia alta Magniez-Jannin, 1975

(pl.2, fig.15)

1975 Uvigerinammia alta Magniez-Jannin:77, pl.6, figs.1-11.

Diagnosis: An elongate species of Uvigerinammia with five to ten chambers.

|    | Length   | Width |
|----|----------|-------|
| 27 | 0.44m.m. | 0.21  |
| 28 | 0.30     | 0.14  |

Description: Test free, elongate in shape with five to ten elongated chambers arranged in a high, loosely coiled trochospire, three chambers in initial whorls, later whorls show a tendency to become biserial; test surface smooth, glossy; aperture terminal, situated on the longitudinal axis of the test; test agglutinated.

Remarks: Magniez-Jannin (1975) first described this species from the upper Middle Albian of the Aube (Courcelles). She recorded it ranging throughout the Albian, occurring more abundantly in the Vraconian.

Stratigraphic conclusion: This species was recorded from the E.loricatus to the S.dispar Zones in southern England where it occurs sporadically and is of stratigraphic significance. Across north-western Europe it has been recorded ranging throughout the Albian and is only of limited stratigraphic value.

Sub-family GLOBOTEXTULARIINAE Cushman, 1927

Genus Arenobulimina Cushman, 1927

Type species: Bulimina presli Reuss, 1846

The species of the genus Arenobulimina have been discussed thoroughly by successive authors with respect to their occurrence and evolution in the Albian. The genera Flourensina Marie, 1938,

Hagenowella Cushman, 1933 and Ataxophragmium Reuss, 1860 have all been mentioned in association with this genus.

The genus Hagenowella was originally defined mainly on the presence of internal partitions but has subsequently been regarded as a junior synonym of the genus Arenobulimina by most authors. This was originally suggested by Barnard & Banner (1953). Voloshina (1965) distinguished separate sub-genera of this genus based on features including:- the rapid expansion of whorls, their degree of convexity, and the shape and number of chambers in the whorls. These sub-genera were thoroughly reviewed, but not adhered to, by Gawor-Biedowa (1969) who also noted that Voloshina (1965) did not give any diagnosis for her proposed sub-genera, and only referred to typical forms. The work of Voloshina was disregarded by both Price (1977a) and Carter & Hart (1977). In addition to all the species which the above authors have recorded, several new species of Albian Arenobulimina have been suggested by both Gawor-Biedowa and Frieg (pers.comm.). Further confusion has been created because many of the species which have been recorded from the Albian were originally described either from the Cenomanian or the Campanian.

Many evolutionary schemes have been suggested for the Albian and Cenomanian species of this genus and Frieg (pers.comm., 1978) has proposed another. All of these schemes have only one common factor:- the evolution of A.macfadyeni to A.chapmani to A.advena. However, they do not agree about the nature of these evolutionary changes or the dates at which they occurred. These schemes almost totally disagree on the form, occurrence, and evolution of the other described Albian species of this genus. The problems stem from the very fundamentals of this subject and are mainly due to the poor original definitions of species, which, associated with poor original figures, atypical holotypes and differences in philosophy, has resulted in a

large amount of confusion within this genus. The present work has emphasised the nature of successive populations and their variability but has not documented the detailed morphological variation of individuals, further study of which can only increase taxonomic confusion.

Various taxonomic features have been regarded as of primary significance in the study of Albian Arenobulimina. Most of these features are environmentally controlled and cannot be considered of major significance in any classification that attempts to be 'natural' and not totally artificial. If a purely artificial taxonomy is adhered to then the number of Albian species of this genus will certainly increase, as will the number of genera and sub-genera. Closely related species will also be assigned to different sub-families (e.g. F.intermedia). If a 'natural' classification is followed then perhaps the number of species described here will be further reduced.

Arenobulimina advena (Cushman, 1936)

(pl.4, figs.10,13.)

- 1936 Hagenowella advena Cushman:43, pl.6, figs.21a,b  
1937b Hagenowella advena Cushman; Cushman:174; pl.21, figs.3a,b,4.  
1945 Hagenowella advena Cushman; Brotzen:44, pl.1, fig.3  
1969 Arenobulimina advena (Cushman); Gawor-Biedowa:86, pl.8, figs.1-4,  
figs.7,8.  
1977 Arenobulimina advena (Cushman); Carter & Hart:14, pl.2, fig.4  
1977a Arenobulimina advena (Cushman); Price:508, pl.59, fig.3

Diagnosis: A large species of Arenobulimina with internal partitions.

|    | Height   | Width |
|----|----------|-------|
| 36 | 0.72m.m. | 0.52  |
| 46 | 1.04     | 0.76  |

Description: A large species; test free, chambers arranged trochospirally; apertural face obliquely truncated, last chamber embraces two-thirds to three-quarters of the test circumference, test circular in cross section; aperture an interiomarginal loop often with a weak lip which is situated in a slight depression in the apertural face; sutures very weakly depressed; in side view test margins convex, strongly converging umbilically; umbilical margin bluntly pointed; last few chambers have internal partitions; greatest width at two-thirds length; wall agglutinated, test surface almost smooth.

Variation: The number of chambers with internal partitions varies from 1 to 4. The size, and the outline, of adult specimens is variable. The apertural lip is not always present.

Remarks: This species was originally described by Cushman (1936) from the Upper Senonian of Junz, Germany. Gawor-Biedowa (1969) noted that Brotzen (1945) showed that Cushman misidentified the locality which was of Upper Cenomanian age. Evidence for this also comes from Swiecicki (pers.comm.) who has not recorded this species from the Upper Senonian of northwestern Europe. Thus the type horizon for this species is probably of Upper Cenomanian age. This view was also taken by Price (1977a) and Carter & Hart (1977).

Cushman originally placed this species in Hagenowella gen.nov. on the basis of internal partitions and subsequently this genus has been regarded as a junior synonym of the genus Arenobulimina. Carter & Hart (1977) based their definition of this species on the presence of internal partitions in the later chambers. They also stated that "there is a complete transition between this species and A.chapmani

at or about the Albian/Cenomanian boundary within Zone 6a". Price (1977a) also regarded this species as a chronospecies evolving from the main A.chapmani plexus in the topmost Albian. However, he also noted that although sectioning many specimens he found no internal partitions, he thus based his concept of this species on the distinct, rounded outline.

In this study a number of specimens with internal partitions were recorded from the topmost Albian of southern England. The presence of internal partitions is here regarded as definitive of this species and specimens without internal partition are regarded as end members of the A.chapmani plexus.

Stratigraphic conclusion: This species occurs in the very topmost Albian of southern England and is of zonal significance.

Arenobulimina chapmani Cushman, 1936

(pl.4, figs.4-9, 12.)

- 1892b Bulimina presli Reuss; Chapman:755, pl.12, fig.14  
1892b Bulimina orbigny Reuss; Chapman:754, pl.12, fig.2  
1936 Arenobulimina chapmani Cushman:26, pl.4, figs.7a,b  
1937a Arenobulimina chapmani Cushman; Cushman:36, pl.3, figs.27a,b, 28  
1950 Arenobulimina chapmani Cushman; Ten Dam:14  
1969 Arenobulimina chapmani Cushman; Gawor-Biedowa:81, pl.5, figs.  
1a,b,2; pl.7, figs.1a,b,2, text figs.3,4  
1975 Arenobulimina chapmani Cushman; Magniez-Jannin:79, pl.7, figs.9-18  
1977a Arenobulimina chapmani Cushman; Price:508, pl.59, fig.4  
1977 Arenobulimina chapmani Cushman; Carter & Hart:15, pl.1, fig.4

Diagnosis: A large sub-conical species of Arenobulimina.



|    | Height   | Width |
|----|----------|-------|
| 39 | 0.57m.m. | 0.34  |
| 40 | 0.67     | 0.47  |
| 41 | 0.65     | 0.47  |
| 42 | 1.0      | 0.67  |
| 43 | 1.1      | 0.39  |
| 44 |          | 0.57  |

Description: A variable species of Arenobulimina; test free; chambers arranged trochospirally; sutures weakly depressed, last chamber embraces one half to two-thirds the test circumference in apertural view; aperture an interiomarginal loop which has a small raised lip; in side view the test margins are weakly convex, margins taper rapidly towards the umbilicus which is sharply pointed; apertural face flattened forming an oblique angle with the axis of the test; in cross section test circular; maximum width at one half to threequarters length; wall agglutinated, test surface moderately agglutinated.

Variation: This species is very variable in most of its 'characteristic' morphological features. The size of specimens and the height/width ratio of specimens varies both within the same population and in time. The average size of adult populations of this species have been plotted for the Glyndebourne borehole (fig.4:1). This illustrates both the increase in the average size of populations in the lower Upper Albian and the variability in the height/width ratio within single populations. The populations become more variable in the highest M.inflatum and S.dispar Zones. Figure 4:2 illustrates the total variation in size of the A.chapmani plexus. It shows that A.sabulosa has the same size range as A.chapmani and that the type specimen of A.chapmani is completely atypical.

Remarks: This species was originally figured by Chapman (1892b)

Fig. 4:1 The width/height ratios of a series of populations of the genus Arenobulimina from the Glyndebourne borehole ( based on the average size of the ten largest specimens from each sample ).

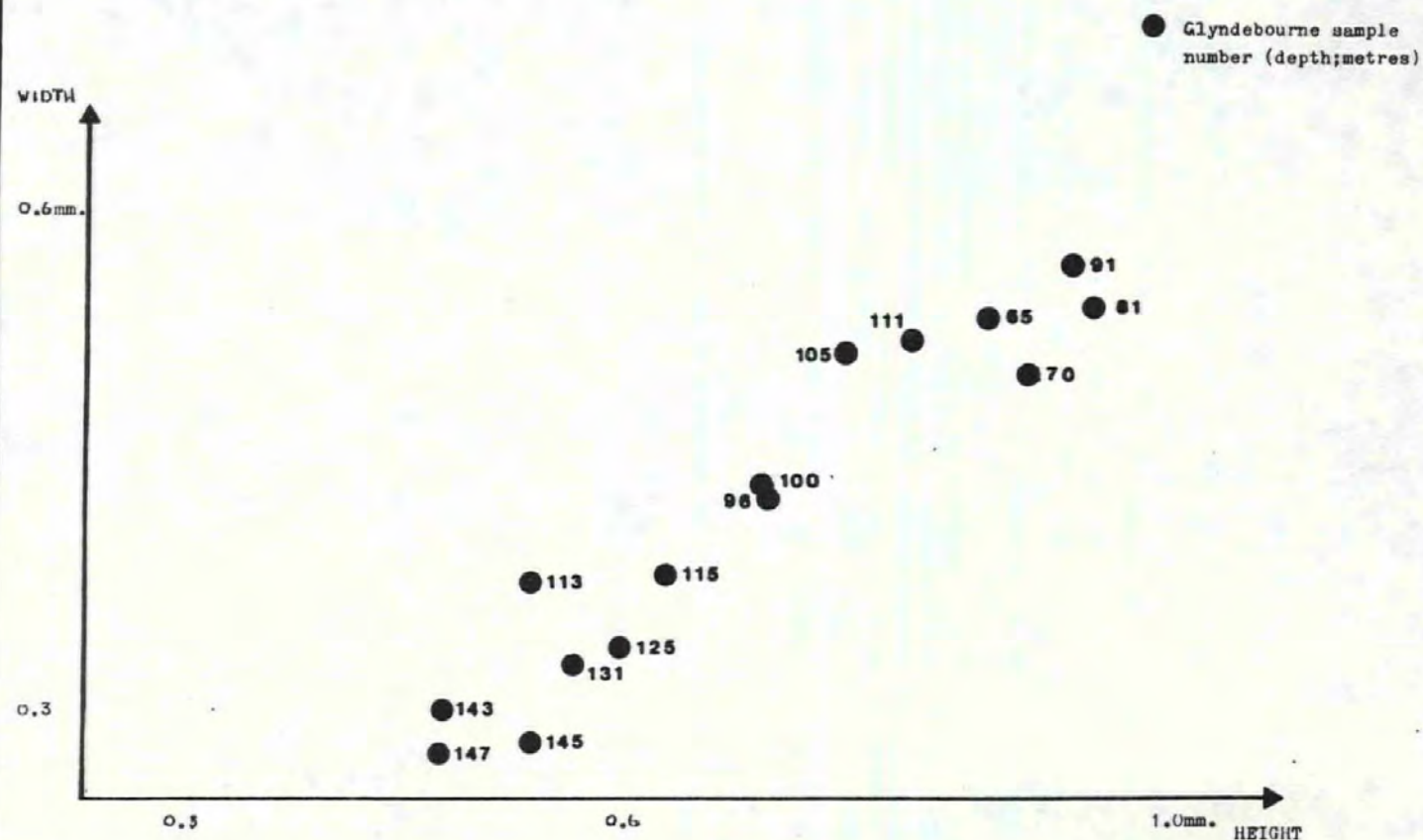
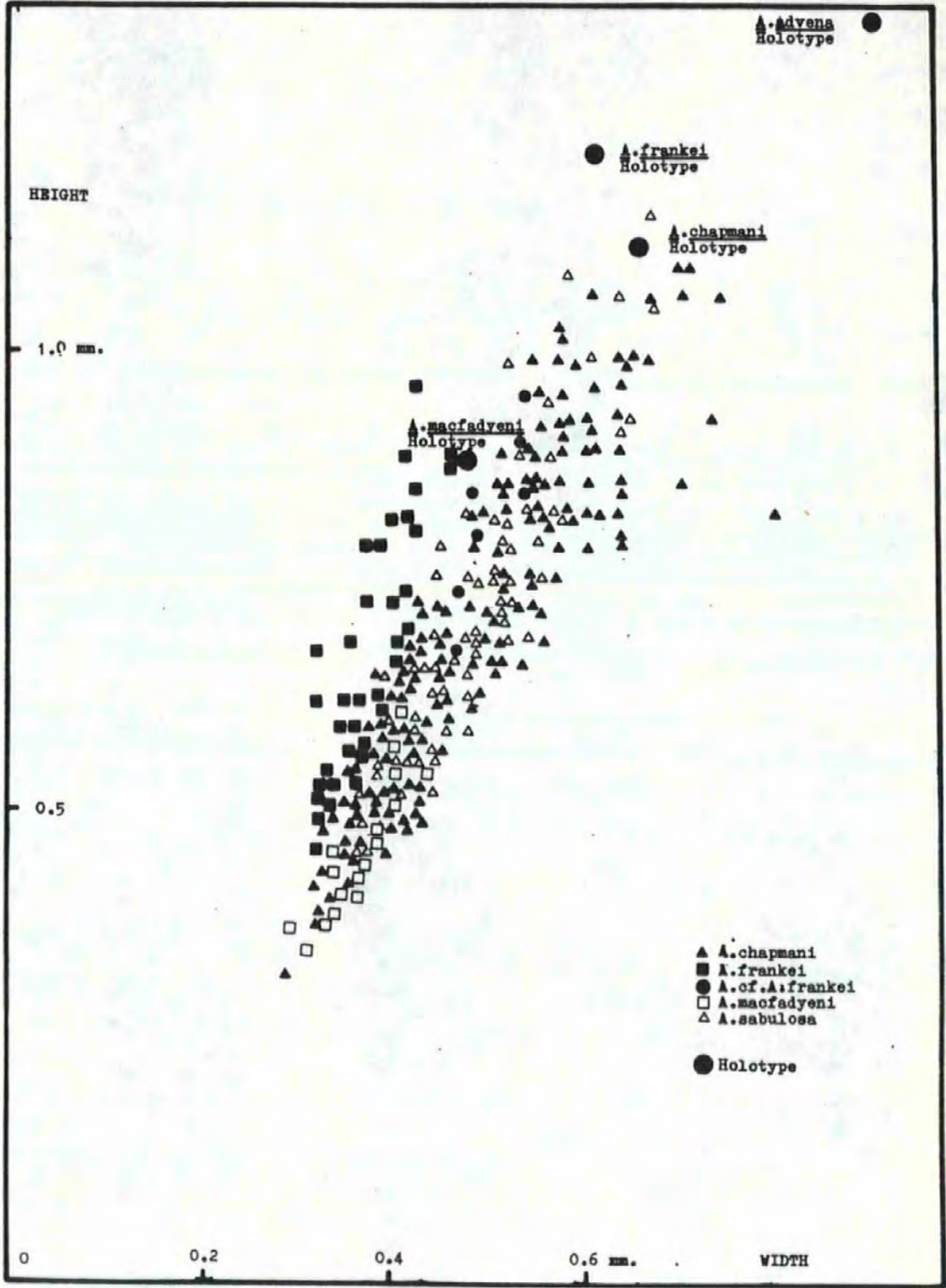


Fig. 4:2      The width/height ratios of individual specimens of the  
genus Arenobulimina.



from the Gault Clay of Folkestone. The specimen he named B.presli was collected from Bed xi at Folkestone. Cushman (1936) recognised this as a separate species, his type specimens were collected from Copt Point where he recorded it as common in Beds X-XIII. He did not include B.orbigny Reuss of Chapman in his original definition. However, Chapman's figured specimen (B.M. no.P4572) is a typical member of the A.chapmani plexus, and it was recorded from Bed x of Copt Point.

This species has been very thoroughly discussed by subsequent authors. Gawor-Biedowa (1969) recognised three distinct generations of this species. However, she stated that the overall test outline of each generation does vary and that she regarded the number of chambers in the last whorl as a specific characteristic. She also provided detailed evidence for the variation in the size of the initial chambers. However, this information could also be interpreted as indicating a gradation in the initial chamber size and not separate generations as she concluded.

This is one of the most abundant of Albian species. It formed the basic stock from which all the other Upper Albian species evolved and itself is a chronospecies which evolved from A.macfadyeni during the early Upper Albian. The early populations show a consistency in their morphology. In the highest part of the M.inflatum Zone some specimens show a tendency to become narrower and some become more strongly agglutinated. These are the initial forms of the species A.sp.cf.A.frankei and A.sabulosa respectively. These forms gradually evolve into the typical A.sp.cf.frankei and A.sabulosa which both first appear in the S.dispar Zone. The main plexus evolves into A.advena in the topmost part of the S.dispar Zone.

Stratigraphic conclusion: This species is very abundant in the Upper Albian and is diagnostic of this Substage.

Arenobulimina frankei Cushman, 1936

(pl.5,fig.8)

- 1936 Arenobulimina frankei Cushman:27,pl.4,figs.5a,b  
1937a Arenobulimina frankei Cushman;Cushman:37,pl.4,fig.21  
1969 Arenobulimina frankei Cushman;Gawor-Biedowa:84,pl.5,figs.4.5;  
pl.7,figs.6,7a,b,8a,b,text figs.5,6  
1977a Arenobulimina frankei Cushman;Price:508,pl.59,figs.5,6,9

Diagnosis: A moderately sized species of Arenobulimina which is triangular in cross section.

|     | Height  | Width |
|-----|---------|-------|
| 36a | 0.7m.m. | 0.36  |

Description: Test free, chambers arranged in a high trochospire, triangular in cross section; aperture an interiomarginal loop which occurs in a slight depression in the apertural face; apertural face weakly obliquely truncated; sutures weakly depressed; last chamber embraces two-thirds of the test circumference; in side view test margins almost straight, strongly tapering posteriorly; apertural end circular in cross section; maximum width at five-sixths length; test agglutinated, wall surface moderately coarsely agglutinated.

Variation: Some specimens show a tendency to become uniserial.

Remarks: This species was originally defined by Cushman (1936) from the Cenomanian of Poland. Gawor-Biedowa (1972) also figured material from the Polish Cenomanian where she recorded it from the uppermost Albian and Cenomanian. Both Carter & Hart (1977) and Price (1977b) recorded this species from the S.dispar Zone. None of these authors noted that the specimens from the Anglo-Paris Basin are narrower and more elongate than specimens from Poland, Germany and the southern North Sea Basin. These two forms are here separated. The difference in size of the forms is illustrated in figure 4:2. The

broader nature of the northern forms may have led Price (1977a) to conclude that F.intermedia evolved from this species. In the present study no gradational specimens of this species were recorded and therefore no conclusions can be made. A.frankei is very similar to Plectina cenomana Carter & Hart, 1977. Indeed Freig (pers.comm.) has included specimens of P.cenomana in his concept of A.frankei. Carter & Hart regarded P.cenomana as characteristic of the Middle and Upper Cenomanian. These specimens are closely related to A.frankei and may indicate a 'boreal' invasion of southern England during the Cenomanian.

Stratigraphic conclusion: A rare species which is limited in distribution to the S.dispar Zone of the 'Boreal' province; of moderate stratigraphic significance.

Arenobulimina sp. cf. A.frankei Cushman, 1936

(pl.5, figs.2-4)

1977 Arenobulimina frankei Cushman; Carter & Hart:15, pl.1, fig.1; pl.2 fig.5

Diagnosis: A narrow, moderately sized, species of Arenobulimina which is triangular in cross section.

|     | Height   | Width |
|-----|----------|-------|
| 37  | 0.93m.m. | 0.42  |
| 38a | 0.82     | 0.42  |
| 38b | 0.85     | 0.40  |

Description: Test free, chambers arranged in a high trochospire; test triangular in cross section; apertural face weakly truncated; aperture an interiomarginal loop which occurs in a slight depression in the apertural face; last chamber embraces two-thirds of the test circumference; in side view margins straight, strongly converging umbilically; test surface moderately agglutinated.

Remarks: This species differs from the boreal form, A.frankei,



by being narrower and lacking the tendency to become uniserial. It is limited in distribution to the Anglo-Paris Basin where it ranges through the uppermost Albian. Carter & Hart (1977) regarded this species as zonally significant ranging through Zones 6 and 6a.

Stratigraphic conclusion: Both A.frankei and A.sp. cf. A.frankei first occur at the base of the M.perinflatum Subzone where they appear to be mutually exclusive. A. sp. cf. A.frankei occurs very rarely in the basal Cenomanian while A.frankei ranges into the Cenomanian.

Arenobulimina macfadyeni Cushman, 1936

(pl.4,figs.1-3)

- 1892b Bulimina obliqua d'Orbigny;Chapman:754,pl.12,fig.8  
 1936 Arenobulimina macfadyeni Cushman:26,pl.4,figs.6a,b  
 1937b Arenobulimina macfadyeni Cushman;Cushman:35,pl.4,figs.13a,b,14  
 1950 Arenobulimina macfadyeni Cushman;Ten Dam:14  
 1967 Arenobulimina presli Reuss;Fuchs:272,pl.4,fig.3  
 1975 Arenobulimina macfadyeni Cushman;Magniez-Jannin:78,pl.8,fig.28  
 1977a Arenobulimina macfadyeni Cushman;Price:510,pl.59,figs.7,8  
 1977 Arenobulimina macfadyeni Cushman;Carter & Hart:15,pl.2,fig.2

Diagnosis: A small species of Arenobulimina with a smooth test surface and a curved test axis.

|     | Height   | Width |
|-----|----------|-------|
| 28a | 0.66m.m. | 0.38  |
| 29  | 0.37     | 0.26  |
| 30  | 0.51     | 0.35  |

Description: A variable species; test free; chambers arranged in a high trochospire; apertural face obliquely truncated, aperture an interiomarginal loop with a weakly raised lip; sutures weakly depressed; last chamber embraces one half to two-thirds the test circumference; test circular in apertural view; test margins weakly concave or convex in side view; test axis curved; margins converge weakly umbilically,

umbilical margin sharply pointed; greatest width at three quarters to five-sixths length; test agglutinated, surface smooth.

Variation: A very variable species. The size, number of chambers, outline, and smoothness of the test surface are all variable. This species becomes larger in the topmost Middle Albian before it evolves into A.chapmani. Specimens from the Yorkshire Albian tend to be larger and have smoother test surfaces.

Remarks: This species was originally described by Chapman (1892b) from the Gault Clay of Folkestone. It was recognised as a separate species by Cushman (1936) whose type specimens were collected from the Gault Clay of Copt Point. However, Cushman failed to define the horizon from which the sample(s) was collected. He also failed to recognise the specimen figured by Chapman (B.M.no.P.4573) as conspecific. This specimen was collected from Bed viii at Folkestone and was incorrectly placed in the synonymy of A. sp. cf. obliqua by Price (1977a). Price regarded this species as ranging from the auritus Subzone upwards. Chapman's figure is misleading and may have confused Price.

The evolution of A.macfadyeni and its distribution in north-western Europe was well documented by Price (1977a) who showed it evolving from a short rounded form in the Lower Albian to an elongate tapering form in the topmost Middle Albian. He also stated that it evolved into A.chapmani during the D.cristatum Subzone, and he thus regarded these two species as chronospecies. However, Carter & Hart (1977) recorded this species both in the Middle Albian and in Upper Albian. They recorded it abundantly in the Upper Albian in coexistence with A.chapmani. The present author prefers the interpretation of Price and regards these two species as chronospecies. Magniez-Jannin (1975) also recorded it from the Lower, Middle and rarely from the lowest Upper Albian of the Aube.

Stratigraphic conclusions: This species occurs rarely in the Lower Albian but is typical of the Middle Albian.



Arenobulimina sabulosa (Chapman, 1892b)

(pl.5, figs. 9, 10, 11.)

1892b Bulimina presli Reuss var. sabulosa Chapman: 755, pl. 12, fig. 5

1937a Arenobulimina sabulosa (Chapman); Cushman: 36, pl. 3, figs. 29, 30

1969 Arenobulimina sabulosa (Chapman); Gawor-Biedowa: 77, pl. 5, figs. 3a, b;  
text figs. 1, 2

1977a Arenobulimina sabulosa (Cushman); Price: 510

1977 Arenobulimina sabulosa (Cushman); Carter & Hart: 17, pl. 1, fig. 2

Diagnosis: A coarsely agglutinated species of Arenobulimina which is quadrate in cross section.

|    | Height   | Width |
|----|----------|-------|
| 32 | 0.56m.m. | 0.42  |
| 33 | 0.65     | 0.43  |

Description: Test free; chambers arranged trochospirally; apertural face obliquely truncated; sutures weakly depressed, irregular due to the coarse grained nature of the test wall; aperture an interiomarginal slit which is situated in a slight depression in the apertural face; in apertural view last chamber embraces two thirds of the test circumference, test circular in cross section; in side view margins are irregularly convex, irregularity is due to both the very coarse agglutinated particles in the test wall and the inflation of the chambers; margins taper strongly towards the umbilicus which is bluntly pointed; wall agglutinated; greatest width at one half to seven eighths length.

Variation: The test wall varies from coarse to very coarse. In cross section early members of this species are circular, later specimens are quadrate.

Remarks: This species was originally figured by Chapman (1892b)

who recorded it from the top twenty feet of Bed xi at Copt Point. This coarsely agglutinated species evolved directly from A.chapmani in the topmost part of the M.inflatum Zone. It evolved gradually from a moderately coarsely agglutinated form with a round cross section to a coarsely agglutinated form with a quadrate cross section. This form appears in the early part of the S.dispar Zone where it gradually becomes less quadrate and more triangular in cross section, eventually evolving into F.intermedia, which first appears in the latest S.dispar Zone. Cushman (1937a) was the first to recognise this as a separate species. He noted that the specimens recorded by Chapman from the 'chalk marl' of Charing belong to a separate species and he recorded it from the uppermost Gault Clay at Copt Point. Gawor-Biedowa (1972) recorded this species from the uppermost Albian and Cenomanian of Poland. However, Price (1977a) did not regard the specimens figured by Gawor-Biedowa as conspecific to those figured by Cushman. This resulted in Price recording this species as having a limited distribution (southern England and the southern North Sea Basin). However, both Gawor-Biedowa and Carter and Hart (1977) regarded this species as much more widely distributed over much of northwest Europe and the present author agrees with this view.

Stratigraphic conclusion: A widely distributed species that occurs abundantly in the mid S.dispar Zone. It is of zonal significance in the Gault Clay facies but was not recorded from the Red Chalk.

Arenobulimina sp. cf. A.truncata (Reuss, 1844)

(pl.5, fig.12.)

1844 Bulimina truncata Reuss:215, pl.8, fig.73

1977b Arenobulimina truncata (Reuss); Price:510, pl.59, fig.12

Diagnosis: A small species of the genus Arenobulimina with a straight test axis.

|    | Height   | Width |
|----|----------|-------|
| 49 | 0.46m.m. | 0.28  |

Description: Test free, small; chambers arranged in a high trochospire, poorly inflated; aperture an interiomarginal loop; wall coarsely agglutinated.

Remarks: Smaller than other Albian species of this genus it may prove to be an ecophenotypic variant (stunted form) of the main Arenobulimina plexus which only occurs fully developed, and in great abundance, in the basinal clay facies.

Stratigraphic conclusion: A rare species of Arenobulimina which was only recorded from the marginal Upper Greensand facies (S.dispar Zone) of Compton Bay, Isle of Wight.

#### Genus Dorothia Plummer, 1931

Type species: Gaudryina bulletta Carsey, 1926

This species was used by Plummer (1931) as the type species of this genus. It differs from species of the genus Gaudryina in having an initial portion of the test which is ovate to sub-ovate in cross section and not sub-triangular or triangular. Bowen (1955) regarded both the genera Dorothia and Marssonella Cushman, 1933 as junior synonyms of the genus Gaudryina. Marssonella was defined on the presence of higher and wider chambers than Dorothia. This morphological difference is not regarded as of generic significance and the genera Dorothia and Marssonella are therefore regarded as synonymous.

Dorothia ozawai (Cushman, 1936)

(pl.3, fig.6.)

- 1936 Marssonella ozawai Cushman:43, pl.4, figs.10a,b  
1937a Marssonella ozawai Cushman; Cushman:59, pl.6, fig.18  
1953 Marssonella ozawai Cushman; Barnard & Banner:205, pl. 9, figs.2a,b  
1975 Dorothia oxycona Cushman; Magniez-Jannin:91, pl.8, figs.18-23  
1977 Marssonella ozawai Cushman; Carter & Hart:12, pl.2, fig.1

Diagnosis: A large, elongate, species of Dorothia with weakly depressed sutures.

|    | Height   | Width |
|----|----------|-------|
| 50 | 0.91m.m. | 0.47  |

Description: Test free, later stage biserial, early stage not observed; chambers gradually increase in size; sutures weakly depressed; aperture a narrow interiomarginal slit; in apertural view test sub-circular; in side view margins weakly concave, sub-parallel, taper more strongly towards the umbilicus which is bluntly pointed; apertural face forms a shallow 'v' shape in side view; wall agglutinated, test surface moderately coarsely grained; greatest width at two thirds to seven eighths length.

Remarks: This species was originally described by Cushman (1936) from the Cenomanian. It was subsequently recognised by Barnard & Banner (1953) and by Carter & Hart (1977). The latter authors recorded it from the topmost Albian and Cenomanian. Magniez-Jannin (1975) provided evidence for the evolution of this species from D. oxycona. She showed this sequence to be gradational, with specimens becoming higher and less wide in the higher Albian. This species is easily distinguished from D. trochus (d'Orbigny, 1840) by its coarse agglutination and sub-parallel sides.

Stratigraphic conclusion: This species occurs sporadically in the S. dispar Zone and is of zonal significance in both the Anglo-Paris Basin and the southern North Sea Basin.

Dorothia trochus (d'Orbigny, 1840)

(pl.3,fig.4.)

- 1840 Textularia trochus d'Orbigny:45,pl.4,figs.25-26  
1880 Gaudryina oxycona Reuss;Berthelin:23  
1892b Gaudryina oxycona Reuss;Chapman:753,pl.12,figs.1a,b  
1892b Textularia turris d'Orbigny;Chapman:750,pl.12,fig.19  
1937a Marssonella oxycona (Reuss);Cushman:56,pl.5,figs.27a-c  
1950 Marssonella oxycona (Reuss);Ten Dam:17  
1954 Marssonella oxycona (Reuss);Bartenstein:39  
1963 Marssonella trochus (d'Orbigny);Barnard:44,pl.7,figs.3a-q  
1967 Marssonella cf. trochus (d'Orbigny);Fuchs:273,pl.4,fig.6  
1972 Dorothia trochus (Reuss);Gawor-Biedowa:30,pl.2,figs.4a-c  
1975 Dorothia levis Magniez-Jannin:87,pl.8,figs.7-17  
?1975 Dorothia oxycona (Reuss);Magniez-Jannin:91,pl.8,figs.18-23

Diagnosis: A sub-concial species of Dorothia.

|  | Height | Width |
|--|--------|-------|
|--|--------|-------|

|    |          |      |
|----|----------|------|
| 51 | 0.60m.m. | 0.43 |
|----|----------|------|

Description: Test free, wide, sub-conical; later chambers biserial; in cross section test sub-ovate; aperture an interior-marginal slit; in side view test margins straight to weakly convex/concave, they converge strongly towards the umbilicus, sutures slightly depressed giving an undulating appearance to the test margins; in side view the anterior margin forms a shallow 'v'; wall agglutinated, surface moderately coarse; greatest width at anterior end.

Variation: This species becomes larger and wider in the uppermost Albian.

Remarks: This species had a very confused history. It was originally described by d'Orbigny from the Campanian and was subsequently named G.oxycona by Reuss who described it as occurring in the Gault Clay, Lower Cenomanian, and Senonian of Germany. The difference between D.trochus and D.oxycona is the rate at which the chambers increase in size. All intermediates between these two end members were recorded in the Albian and as they have also been recorded as high as the Campanian (Swiecicki, pers. comm., 1980) these two species are here regarded as conspecific. This conclusion was also reached by Barnard & Banner (1953), Price (MS.) and Carter & Hart (1977).

Two closely allied species occur in the S.dispar Zone; D.ozawai and Pseudotextulariella cretosa (Cushman, 1932). These both evolve from the basic D.trochus plexus, the former becomes more elongated and has more depressed sutures, the latter becomes broader and develops internal partitions. Magniez-Jannin (1975) erected a new species from the Albian of the Aube, Dorothia levis Magniez-Jannin, 1975 which she regarded as the Middle Albian precursor to D.oxycona. These two species are regarded here as conspecific. D.levis merely represents a stunted form of D.trochus.

Gawor-Biedowa (1972) figured a strongly conical form of D.trochus. She also stated that this has a similar stratigraphic range to P.cretosa, which although externally similar, possesses internal partitions.

Stratigraphic conclusion: A long ranging species whose distribution and appearance are environmentally controlled. It is of limited stratigraphic significance.

Genus Eggerellina Marie, 1941

Type species: Bulimina brevis d'Orbigny, 1840

Eggerellina mariae Ten Dam, 1950

(pl.2,figs.10,12.)

1950 Eggerellina mariae Ten Dam:15,pl.1,fig.17

1972 Eggerellina mariae Ten Dam;Gawor-Biedowa:33,pl.3,figs.1a,b,2a,b

1975 Eggerellina mariae Ten Dam;Magniez-Jannin:94,pl.6,figs.12-21

1977 Eggerellina mariae Ten Dam;Carter & Hart:17,pl.2,fig.7

Diagnosis: A sub-conical species of Eggerellina with inflated embracing chambers.

|    | Height   | Width |
|----|----------|-------|
| 52 | 0.33m.m. | 0.29  |
| 53 | 0.46     | 0.24  |

Description: A variable species; test free; sub-conical to sub-ovoid; triserial with inflated and embracing chambers; chambers inflate at various rates, specimens vary from high spired and narrow to low spired and wide; normally 6 to 9 chambers per specimen; aperture narrow, hook shaped and interiomarginal. Test agglutinated, test surface smooth, glossy.

Remarks: This species was originally described by Ten Dam (1950) from the Gault Clay of Holland as a very variable species. It has a confused history. It was originally defined as differing from E.gibbosa Marie, 1941, by being squatter and having a last whorl consisting of two and a half chambers. Price (MS.) regarded these two species as synonymous but retained the name E.mariae Ten Dam. This species is therefore considered as varying from short and pyramidal to long and narrow (Carter & Hart). Carter & Hart (1977) recorded it from Zone 5 into the Cenomanian and Price (1977b) regarded it as zonally significant ranging from the base of the H.varicosum Subzone to the Cenomanian. Magniez-Jannin (1975) recorded it

from the topmost Upper Albian and Vraconian of the Aube. She also noted that both the conical and ovoid forms of this species were recorded from the Aube and that certain variants approach the forms described from the Upper Cretaceous as Bulimina brevis d'Orbigny, 1840, E. gibbosa Marie, 1941, and E. intermedia var. globulosa Marie, 1941. She did not regard these variants as constituting separate species.

Stratigraphic conclusion: A common species which first occurs in the C. auritus Subzone. This species is of zonal significance.

Family PAVONITINIDAE Loeblich & Tappan, 1961

Sub-family PFENDERININAE Smout & Sugden, 1962

Genus Pseudotextulariella Barnard in Barnard & Banner, 1953

Type species: Textulariella cretosa Cushman, 1932

Pseudotextulariella cretosa (Cushman, 1932)

(pl.3, fig.5.)

1932 Textulariella cretosa Cushman:97, pl.11, figs.17-19

1937a Textulariella cretosa Cushman; Cushman:61, pl.6, figs.26-28

1953 Pseudotextulariella cretosa (Cushman); Barnard in Barnard &  
Banner:198, text figs.6b-i

1972 Pseudotextulariella cretosa (Cushman); Gawor-Biedowa:34, pl.3,  
figs.4a, b

?1975 Pseudotextulariella cretosa (Cushman); Carter & Hart:95, pl.6,  
fig.24

1977 Pseudotextulariella cretosa (Cushman); Carter & Hart:23, pl.2,  
fig.12

Diagnosis: A large, sub-conical, species of Pseudotextulariella with internal partitions.



|    | Height   | Width |
|----|----------|-------|
| 54 | 0.59m.m. | 0.68  |

Description: Test free, sub-conical, strongly flared; initial chambers are triserial, later stage biserial; biserial portion circular in cross section; chambers wide but not high; aperture an interiomarginal slit, apertural face weakly concave; in side view this species is strongly flared with concave to straight test margins which converge less towards the umbilicus; in side view anterior margin forms a shallow 'v'; greatest width at anterior end, width is similar to height; wall agglutinated, test surface finely agglutinated.

Remarks: This species was originally described by Cushman (1932) from the Cenomanian. It was placed in a new genus by Barnard (1953) who recorded it first appearing in the topmost Albian. Gawor-Biedowa (1972) recorded this distinctive species from the boundary layers between the Albian and Cenomanian and the Cenomanian itself. It was also recorded by Magniez-Jannin (1975) from the Vraconian of the Aube and by Carter & Hart (1977) from the Cenomanian. The latter authors remarked that this species does not occur in the Albian, however, although this appears to be correct in southern England, strongly flared specimens of this species occur in the Red Chalk. These specimens clearly evolve from flared specimens of D. trochus in the topmost S. dispar Zone where the formation of these partitioned chambers is probably due to the need to strengthen the enlarged chambers.

Stratigraphic conclusion: This species occurs very sporadically in the topmost Albian of the southern North Sea Basin. It is of moderate stratigraphic significance.

Suborder MILIOLINA Delage & Herouard, 1896

Superfamily MILIOLACEA Ehrenberg, 1839

Family NUBECULARIIDAE Jones, 1875

Sub-family SPIROLOCULININAE Wiesner, 1920

Genus Spiroloculina d'Orbigny, 1826

Type species: Spiroloculina depressa Cushman, 1917

Spiroloculina papyracea Burrows, Sherborn & Bailey, 1890

(pl.1, figs.10,11,14.)

1890 Spiroloculina papyracea Burrows, Sherborn & Bailey:551, pl.8, fig.1

1891 Spiroloculina asperula Karrer; Chapman:573, pl.9, fig.4

1950 Spiroloculina papyracea Burrows, Sherborn & Bailey; Ten Dam:18,  
pl.1, fig.19

1967 Spiroloculina papyracea Burrows, Sherborn & Bailey; Fuchs:277,  
pl.5, fig.8

1975 Spiroloculina papyracea Burrows, Sherborn & Bailey; Magniez-Jannin:  
95, pl.15, figs.2-4

1977 Spiroloculina papyracea Burrows, Sherborn & Bailey; Carter & Hart:  
24, pl.1, fig.6

Diagnosis: A moderately-sized, compressed, species of  
Spiroloculina.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 59 | 0.60m.m. | 0.43  | 0.06      |
| 60 | 0.36     | 0.22  |           |
| 61 | 0.40     | 0.24  |           |

Description: A compressed species; test free; in side view test fusiform in outline; chambers added two to a whorl on alternate sides of the proloculus and in a single plane; aperture ovate, terminal, no tooth visible; in apertural view test very compressed.

Variation: Uppermost Albian specimens are larger and possess more chambers than earlier Albian specimens.

Remarks: This species was originally described from the Red Chalk of Speeton. Unfortunately the type specimen is broken and is mounted in resin and therefore the true nature of it cannot be ascertained. A similar form was described by Chapman (1891) from Bed xi at Folkestone. This species has subsequently been described from much of northwest Europe. The Red Chalk specimens are generally larger with more rounded chambers than the typical Gault Clay specimens which are, however, regarded as conspecific.

This species was regarded as zonally significant by Carter & Hart (1977) who recorded it ranging from their Albian Zone 5 through into the Cenomanian. Price (1977b) also regarded it as zonally significant occurring from the H. varicosum Subzone through to the Cenomanian.

Stratigraphic conclusion: This species first appears in the basal H. varicosum Subzone of southern England. It is regarded as of zonal significance in the Upper Albian.

Sub-family NODOBACULARIINAE Cushman, 1927

Genus Nodobacularia Rhumbler, 1895

Type species: Nubecularia tibia Jones & Parker, 1860

Nodobacularia nodulosa (Chapman, 1891.)

(pl.1, fig.4.)

1891 Nubecularia nodulosa Chapman:573, pl.9, fig.2

1950 Pseudonubeculina nodulosa (Chapman) Ten Dam:18, pl.1, fig.20

1967 Nodobacularia nodulosa (Chapman) Fuchs:278, pl.5, figs.1,2

1975 Pseudonubeculina nodulosa (Chapman); Magniez-Jannin:96, pl.15,  
fig.2

1977 Nodobacularia nodulosa (Chapman); Carter & Hart:24, pl.1, fig.5

Diagnosis: A small species of Nodobacularia with nodular chambers separated by a thin tubular neck.

|    | Length   | Width |
|----|----------|-------|
| 55 | 0.55m.m. | 0.19  |

Description: A small elongate species; test free; characterised by inflated chambers which are separated by long smooth tubular extensions aperture round, at end of tubular neck; spherical chamber coarsely agglutinated.

Remarks: Chapman (1891) originally described this species from Bed iv to Bed xi at Folkestone, only occurring commonly in Bed xi. It has subsequently been recorded from the Middle and Upper Albian of the Anglo-Paris Basin and from the Middle Albian of Holland. Both Price (1977b) and Carter & Hart (1977) regarded this species as zonally significant. Price recorded it from the topmost D.cristatum Subzone onwards while Carter and Hart described it as ranging through their Zones 4 and 5a, "with rare and scattered specimens being found in Zone 6".

Stratigraphic conclusion: This species was recorded from the base of the A.intermedius Subzone to the top of the H.varicosum Subzone in southern England. It occurs very sporadically but is of moderate stratigraphic significance.

Sub-family QUINQUELOCULININAE Cushman, 1917

Genus Quinqueloculina d'Orbigny, 1826

Type species: Serpula seminulum Linne', 1758

Quinqueloculina antiqua (Franke, 1928.)

(pl.1, figs.5,8,9.)

1891 Miliolina ferussacii (d'Orbigny); Chapman:575, pl.9, fig.8

1891 Miliolina venusta Karrer; Chapman:574, pl.9, figs.5,6

1891 Miliolina tricarinata (d'Orbigny); Chapman:575, pl.9, fig.9

- 1928 Miliolina (Quinqueloculina) antiqua Franke:126,pl.11,fig.26
- 1950 Quinqueloculina antiqua (Franke);Ten Dam:17,pl.1,fig.18
- 1967 Quinqueloculina antiqua (Franke);Fuchs:279,pl.5,figs.5a,b
- 1972 Quinqueloculina antiqua (Franke);Gawor-Biedowa:35,pl.3,figs.6a-c
- 1975 Quinqueloculina antiqua (Franke);Magniez-Jannin:97,pl.15,figs.  
5-9.
- 1977 Quinqueloculina antiqua (Franke);Carter & Hart:25,pl.1,figs.7,8

Diagnosis: A small species of Quinqueloculina.

|    | Length   | Width 1 | Width 2 |
|----|----------|---------|---------|
| 56 | 0.32m.m. | 0.20    | 0.17    |
| 57 | 0.46     | 0.23    | 0.14    |
| 58 | 0.45     | 0.27    | 0.15    |

Description: A small species; test free; chambers coiled around an elongate axis; aperture terminal, circular at end of short neck; in apertural view test sub-triangular; in side view test not very elongate in comparison to test width; test surface smooth.

Remarks: This species was originally described by Franke (1928) from the Turonian of Gristow, Germany. Ten Dam (1950) recognised that the specimens figured by Chapman (1891) from the Gault Clay of Folkestone are conspecific to the species of Franke. Chapman recorded this as three separate species which are here regarded as separate forms of the same species. He recorded this species as ranging from Bed x at Copt Point through to the Cenomanian. Magniez-Jannin (1975) recorded this species as first appearing in the middle part of the Upper Albian and ranging into the Cenomanian while both Price (1977b) and Carter and Hart (1977) regarded it as of zonal significance. Carter & Hart recorded it first occurring in their Zone 2 but only occurring in abundance from Zone 4 onwards. Price

(1977b) separated the two major forms recorded by Chapman as distinct species. He recorded Q.antiqua ranging from the H.spathi Subzone onwards, but only occurring in abundance from the H.orbignyi Subzone onwards. He recorded Q.ferussacii Chapman, 1891 occurring commonly from the H.varicosum Subzone onwards.

Since Q.antiqua and Q.ferussacii are here regarded as synonymous, and because the latter species was named first this species name should be upheld. However, since the former name has been used by all recent authors this name is upheld to maintain taxonomic conformity.

Stratigraphic conclusion: This species occurs very sporadically in the Middle and lower part of the Upper Albian. It only occurs abundantly from the base of the H.varicosum Subzone onwards and is an important indicator of this horizon.

Suborder ROTALIINA Delage & Hérouard, 1896

Superfamily NODOSARIACEA Ehrenberg, 1838

Family NODOSARIIDAE Ehrenberg, 1838

Sub-family NODOSARIINAE Ehrenberg, 1838

The Superfamily Nodosariacea has been thoroughly studied by Magniez-Jannin (1975) who also reviewed much of the work of Marie (1938, 1965) and published detailed text-figures illustrating the variation of many of these species. However, there is still a great deal of taxonomic confusion associated with this group and the problem of reiteration is always evident. The proven stratigraphically significant species have therefore only been recorded. The remaining specimens were included as "Nodosariacea" spp. in the graphical data.

Genus Citharina d'Orbigny in De La Sagra, 1839

Type species: Vaginulina (Citharina) strigillata Reuss, 1846

Citharina d'Orbigny Marie, 1938

(pl.6, fig.9)

?1863 Vaginulina discors Koch; Reuss:50, pl.3, figs.10-12

1938 Citharina d'Orbignyi Marie:95, pl.8, figs.8a,b

1938 Citharina cf. discors (Koch); Marie:96, pl.8, figs.10a,b

1938 Citharina cf. discors (Koch) var gracilis Marie:97, pl.8, figs.9a,b

1950a Vaginulina mariei Khan:270, pl.1, fig.16

1975 Citharina d'Orbignyi Marie; Magniez-Jannin:205, pl.14, figs.2-7

Diagnosis: A species of Citharina with prominent, longitudinal striations on test surface.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 63 | 2.78m.m. | 0.95  | 0.34      |

Description: Test free, elongate, sub-triangular, flattened; chambers are arranged uniserially, poorly curved, gradually increasing in size; aperture terminal, slightly produced, rounded; test surface

partly covered by longitudinal striations.

Remarks: This species was originally figured by Reuss (1863) from the Gault Clay of northern Germany. It was recognised as a distinct species by Marie (1938). Khan (1950) did not regard his specimens as conspecific to the species recorded by Marie (1938) and recorded it from the H.dentatus Zone of Dunton Green, Kent.

Magniez-Jannin (1977) thoroughly reviewed this species. She divided it into four chronoforms and recorded it from the Lower and Middle Albian of the Aube. Price (1977b) regarded this species as zonally significant and recorded it ranging from the L.lyelli to the A.intermedius Subzone.

Stratigraphic conclusion: A rare species which is generally indicative of the Lower and lower Middle Albian. It is of limited stratigraphic value because of its scarcity.

Genus Citharinella Marie, 1938

Type species: Flabellina karreri Berthelin, 1880

Citharinella laffittei Marie, 1938

(pl.6, fig.5.)

- 1938 Citharinella laffittei Marie:101, pl.8, figs.2a,b  
?1975 Citharinella lemoinei Marie; Magniez-Jannin:214, pl.14, fig.13  
1977 Citharinella laffittei Marie; Carter & Hart:25, pl.2, fig.13

Diagnosis: An elongate species of Citharinella which is characterised by a large number of discontinuous, longitudinal striations.

|    | Length  | Width |
|----|---------|-------|
| 62 | 3.8m.m. | 0.67  |

Description: Test free, elongate, flattened flabelliform; chambers are arranged uniserially, 'v' shaped, gradually increasing in size; aperture terminal, slightly produced, round; test surface covered



by discontinuous longitudinal striations; chambers much longer than wide.

Remarks: This species was first described by Marie (1938) from the S.dispar Zone. However, he also defined another species, C.lemoinei, which he described from the C.auritus Subzone stating that it was recorded in the same samples as C.pinnaeformis. He regarded this species as being characterised by rare, thick, longitudinal striations and not by a number of small longitudinal striations, as in C.lemoinei Marie, 1938. He further confused this species by figuring a smooth specimen (1938) while also figuring (Marie, 1965:pl.2,fig.11) a specimen of C.laffittei with almost continuous longitudinal striations. He also (1965) figured a specimen of C.lemoinei with fine, discontinuous, longitudinal ribs. This species is therefore very confused, and it may be that these two species defined by Marie (1938) are conspecific. Chapman (1894a;157,pl.3,fig.15) recorded a similar species from Bed xi at Folkestone which he attributed to Frondicularia lanceola Reuss, 1860.

Carter and Hart (1977) regarded this species as zonally significant occurring commonly in their Zone 6a, and ranging from Zone 5a into the Cenomanian.

Stratigraphic conclusion: This species occurs sporadically in the S.dispar Zone. It is of moderate stratigraphic significance.

Citharinella pinnaeformis (Chapman, 1894)

(pl.6,fig.4)

- 1893b Frondicularia pinnaeformis Chapman:156,pl.3,figs.9-11 (1894)  
1938 Citharinella pinnaeformis (Chapman); Marie:100,pl.7,figs.7-9;  
pl.8,figs.4-6  
1950 Citharinella pinnaeformis (Chapman);Ten Dam:38  
1975 Citharinella pinnaeformis (Chapman);Magniez-Jannin:215,pl.14,  
figs.14,15

1977 Citharinella pinnaeformis (Chapman); Carter & Hart: 25, pl. 1, fig. 9

Diagnosis: A large species of Citharinella which is characterised by four prominent, longitudinal axial ribs, two on each side of the test.

|     | Length   | Width |
|-----|----------|-------|
| 61a | 3.39m.m. | 1.17  |

Description: Test free, flattened, palmate; chambers arranged uniserially, 'v' shaped, gradually increase in size; aperture terminal, slightly produced, round; test surface bears four prominent longitudinal axial ribs, two on each side; test surface smooth.

Remarks: This distinctive species was first described by Chapman (1894) ranging from Bed ix to the base of Bed xi at Folkestone. It was placed in the genus Citharinella by Marie (1938) who recorded it from the Gault Clay of France. Magniez-Jannin (1975) regarded this species as stratigraphically important in the Aube where she recorded it from the mid-and upper part of the Upper Albian. Carter & Hart (1977) also regarded this species as of zonal significance. They recorded it ranging from their Zone 4a to their Zone 5a with possibly derived specimens in Zone 6. Price (1977b) regarded it as stratigraphically significant and recorded it as ranging from the E.nitidus Subzone to the H.varicosum Subzone.

Stratigraphic conclusion: In southern England this species occurs sporadically in the M.inflatum Zone where it is of zonal significance. It is only of localised stratigraphic importance.

Genus Frondicularia DeFrance in d'Orbigny, 1826

Type species: Renulina complanata DeFrance, 1824

Frondicularia filocinta Reuss, 1863

(pl. 6, fig. 1.)

1863 Frondicularia filocinta Reuss: 54, pl. 4, fig. 11

- 1880 Fron dicularia ungeri Reuss; Berthelin: 61, pl. 4, fig. 4
- 1893b Fron dicularia ungeri Reuss; Chapman: 157, pl. 3, fig. 16
- 1893b Fron dicularia parkeri Reuss; Chapman: 157, pl. 3, fig. 17
- 1893b Fron dicularia guestphalica Reuss; Chapman: 158, pl. 8, fig. 4
- 1893b Fron dicularia microdiscus Reuss; Chapman: 158, pl. 4, fig. 3
- 1893b Fron dicularia perovata Chapman: 158, pl. 4, figs. 5a, b
- 1893b Fron dicularia cordai Reuss; Chapman: 159, pl. 4, fig. 6
- 1933 Fron dicularia ungeri Reuss; Eichenberg: 8, pl. 6, figs. 1a, b
- 1950 Fron dicularia ungeri Reuss; Ten Dam: 33, pl. 2, fig. 26
- 1975 Fron dicularia filocinta Reuss; Magniez-Jannin: 201, pl. 14, figs. 17-22, text fig. 108

Diagnosis: A large species of Fron dicularia with a short, longitudinal, umbilical rib.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 64 | 4.27m.m. | 1.95  | 0.17      |

Description: Test free, compressed, uniserial, palmate; chambers rapidly increasing in size in early part, later chambers increase slowly in size; chamber surface smooth; aperture slightly produced, round, central at greatest height; umbilical boss weak; short longitudinal rib situated umbilically.

Remarks: This species was originally described by Reuss (1863) from the Gault Clay of northern Germany. It was also recorded by both Berthelin (1880) and by Chapman (1894a) from the Anglo-Paris Basin. However, Chapman divided this group into six separate species.

Magniez-Jannin (1975) recorded this species from the Aube and noted that it is characterised by an oval proloculus which bears a straight, vertical, median rib. She described this species in great detail and divided it into two chronoforms which she separated on size and ornament. She stated that the younger of these forms has a better developed rib which is similar to the holotype.

Stratigraphic conclusion: This species occurs sporadically in the Middle and Upper Albian. It is of limited stratigraphic value.

Genus Vaginulina d'Orbigny, 1826

Type species: Nautilus legumen Linné, 1758

Vaginulina ex.gr.V.Kochii Roemer, 1841

(pl.6, figs.2,7.)

- 1841 Vaginulina kochii Roemer:96,pl.15,fig.10
- 1863 Vaginulina eurynota Reuss:90,pl.12,figs.9a,b
- 1863 Vaginulina protosphaera Reuss:90,pl.12,figs.10a,b
- 1863 Vaginulina striolata Reuss:46,pl.3,fig.7
- 1863 Vaginulina strombecki Reuss:46,pl.3,fig.8
- 1863 Vaginulina truncata Reuss:47,pl.3,fig.9
- 1880 Vaginulina comitina Berthelin:38,pl.1,figs.21c,d
- 1880 Vaginulina gaultina Berthelin:39,pl.1,figs.22a,b,23a-c,24
- 1880 Vaginulina truncata Berthelin:39,pl.1,figs.25-27
- 1894a Vaginulina arguta Reuss;Chapman:425,pl.8,figs.9a,b
- 1894a Vaginulina comitra Berthelin;Chapman:426,pl.8,fig.11
- 1894a Vaginulina gaultina Berthelin;Chapman:425,pl.8,figs.8a,b
- 1894a Vaginulina striolata Reuss;Chapman:425,pl.8,fig.10
- 1894a Vaginulina truncata Reuss;Chapman:423,pl.8,figs.5a,b,6
- 1940 Vaginulina kochii Roemer;Tappan:109,pl.17,figs.2-4
- 1940 Vaginulina kochii Roemer var.striolata Reuss;Tappan:110,pl.17,  
fig.5
- 1950 Vaginulina kochii Roemer;Ten Dam:34
- 1950 Vaginulina kochii Roemer var. striolata (Reuss);Ten Dam:35
- 1954 Vaginulina gaultina Berthelin;Bartenstein:43,pl.1,figs.1-12
- 1967 Vaginulina constulata Roemer;Fuchs:310,pl.14,fig.13
- 1975 Lenticulina/Vaginulina kochii kochii (Roemer);Magniez-Jannin:  
166,pl.14,figs.26-28,text figs.90k,a-i

- 1975 Lenticulina/Vaginulina kochii (Roemer)striolata(Reuss);  
Magniez-Jannin:169,pl.14,figs.31,32,text figs.90-93
- 1975 Lenticulina/Vaginulina(Roemer)truncata(Reuss),Magniez-Jannin:  
166,pl.14,figs.29-30;text figs.90-93

Diagnosis: A compressed, elongate, species of Vaginulina.

|    | Length | Width | Thickness |
|----|--------|-------|-----------|
| 65 | 1.67   | 0.84  | 0.40      |
| 66 | 2.28   | 0.71  | 0.41      |

Description: Test free, compressed, elongate; weak ribs are present along sutures and around the margins of the test; chambers uniserial, gradually increase in size; aperture produced, at greatest height of test; umbilical boss small.

Remarks: This variable species illustrates the taxonomic confusion that can occur when single specimens and not populations are studied. Many early workers split it into several separate species and recent workers have also suggested schemes for subdividing it. The most recent of these attempts was by Magniez-Jannin (1975) who published a very thorough review of this species and decided to divide it into three sub-species. These were defined on the size of the proloculus, overall size, and surface ornament. She indicated (text-figs. 91-93.) that the proloculus of these sub-species are gradational in size and that V.robusta has a larger proloculus than any of these three sub-species. This species, similar to many Albian species, is smaller in the Lower and lower Middle Albian, and increases in size during the Upper Albian.

Stratigraphic conclusion: A common species that occurs sporadically throughout the Albian. It is of limited stratigraphic value.

Vaginulina mediocarinata Ten Dam, 1950

(pl.6,fig.6.)

- 1894a Vaginulina strigillata Reuss;Chapman:423,pl.8,figs.3a,b,4  
1950 Vaginulina mediocarinata Ten Dam:36,pl.3,figs.3a-d  
1967 Vaginulina albiensis Fuchs:308,pl.14,figs.4a,b  
1975 Vaginulina mediocarinata Ten Dam;Magniez-Jannin:174,pl.14,fig.24  
1977 Vaginulina mediocarinata Ten Dam;Carter & Hart:26,pl.2,fig.14

Diagnosis: A flattened species of Vaginulina which has a test surface that is covered by a number of longitudinal striations.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 68 | 2.24m.m. | 0.51  | 0.20      |

Description: Test free, flattened, elongate; chambers arranged uniserially, slightly arcuate; a sharply defined rib is present around the entire margin; a median longitudinal rib is present around the edge of the test; chambers increase slowly in size; aperture slightly raised at greatest test height, round.

Remarks: This species was originally described by Chapman (1894a) from Bed x at Folkestone. Magniez-Jannin (1975) recorded it from the middle Upper Albian to the Vraconian of the Aube. Carter & Hart (1977) regarded it as a zonally significant species occurring in their zones 4a-6 of southern England. Price (1977b) also regarded it as zonally significant occurring from the D.niobe Subzone to the Cenomanian. He also stated that it has been recorded ubiquitously from across northwestern Europe.

Stratigraphic conclusion: A rare species that occurs sporadically in the Middle and Upper Albian. It is of moderate stratigraphic value.

Vaginulina robusta Berthelin, 1880

(pl.6, fig.3.)

1880 Vaginulina truncata Reuss Var. Robusta Berthelin:39, pl.2, figs.4a,b

1894a Vaginulina truncata Reuss var. robusta Berthelin;

Chapman:424, pl.8, figs.7a,b

1950 Vaginulina robusta (Chapman); Ten Dam:35, text fig.3

1967 Vaginulina truncata robusta Berthelin; Fuchs:313, pl.13, figs.6a,b

1975 Lenticulina/Vaginulina/robusta (Chapman); Magniez-Jannin:170, pl.

14, figs.33,34, text figs.90r a,b

Diagnosis: A large, heavily calcified, species of Vaginulina.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 67 | 1.62m.m. | 0.51  | 0.42      |

Description: Test free, strongly calcified, uniserial; strong ribs are present along sutures and around margins of test; chambers gradually increase in size, thick; aperture slightly produced at greatest height of test; umbilical boss well developed, it is crossed by a short diagonal rib which is parallel to the sutural ribs; chamber surfaces smooth.

Remarks: This species was described by Chapman (1894a) as differing from the type form of V.truncata in having a much thicker and coarser growth. Magniez-Jannin (1975) showed that this species has a larger proloculus than V.kochii with which it is closely related.

Stratigraphic conclusion: A sporadically occurring species which is of limited stratigraphic value.

Genus Planularia Defrance in De Blainville, 1826

Planularia ex.gr.P.complanata (Reuss, 1845.)

(pl.6, fig.10.)

1845 Cristellaria complanata Reuss:33, pl.13, figs.54a,b

1863 Cristellaria complanata Reuss; Reuss:92, pl.12, figs.13a,b

- 1880 Cristellaria complanata Reuss; Berthelin: 54
- 1894b Cristellaria complanata Reuss; Chapman: 653, pl. 10, figs. 10a, b
- 1940 Vaginulina complanata (Reuss); Tappan: 107, pl. 16, figs. 23a, b, 24
- 1950 Vaginulopsis complanata (Reuss); Ten Dam: 39, pl. 3, fig. 10
- 1975 Lenticulina/Planularia complanata complanata (Reuss); Magniez-Jannin: 154, pl. 9, figs. 29, 30, text fig. 83b
- 1975 Lenticulina/Planularia complanata granifera (Reuss); Magniez-Jannin: 151, pl. 9, figs. 26-28, text fig. 83a
- 1975 Lenticulina/Planularia complanata ornatissima (Reuss); Magniez-Jannin: 155, pl. 9, figs. 37, 38, text fig. 38e
- 1975 Lenticulina/Planularia complanata spinigera (Reuss); Magniez-Jannin: 153, pl. 9, figs. 29, 30, text fig. 83b

Diagnosis: A moderately sized species of Planularia.

|    | Length   | Width | Thickness |
|----|----------|-------|-----------|
| 71 | 0.91m.m. | 0.40  | 0.14      |

Description: Test free, compressed, uniserial, elongate with curved margins; chambers increase rapidly in size; aperture at greatest height, weakly produced; surface smooth or weakly striate; the posterior margin may bear several short spines.

Remarks: This distinctive species was originally described by Reuss (1863), who recorded it from the Gault Clay of Folkestone, but not from northern Germany. This species has subsequently been recorded from Holland and from the Aube. Magniez-Jannin (1975) published a very thorough study of this species in which she subdivided it into four chronosubspecies. These were separated on the size and ornamentation of the populations. She showed that the size of specimens increased during the topmost Middle Albian and Upper Albian.

Stratigraphic conclusion: A rare species which occurs sporadically in the Middle and Upper Albian of the Anglo-Paris Basin.



It is of limited stratigraphic value.

Sub-family RAMULININAE Brady, 1884

Genus Ramulina Jones in Wright, 1875

Type species: Ramulina laevis Jones in Wright, 1875

Ramulina spp.

(pl.6,fig.8)

|    | Length   | Width |
|----|----------|-------|
| 45 | 0.23m.m. | 0.14  |

Due to the variation exhibited in the morphology of the species of this genus no individual species has been described. Individuals have been utilised to illustrate the change in the populations during the Albian (fig.4:3 ). This illustrates the change from populations consisting mainly of small globular individuals in the Middle Albian to larger branching specimens in the Upper Albian.

Family UVIGERINIDAE Haeckel, 1894

Genus Siphogenerina Schlumberger in Milne-Edwards, 1882

Type species: Siphogenerina costata Schlumberger, 1883

Siphogenerina asperula (Chapman, 1896).

(pl.6,fig.11.)

1896. Sagrina asperula Chapman:581,pl.12,fig.1

1933 Uvigerina asperula (Chapman);Eichenberg:18,pl.1,fig.3

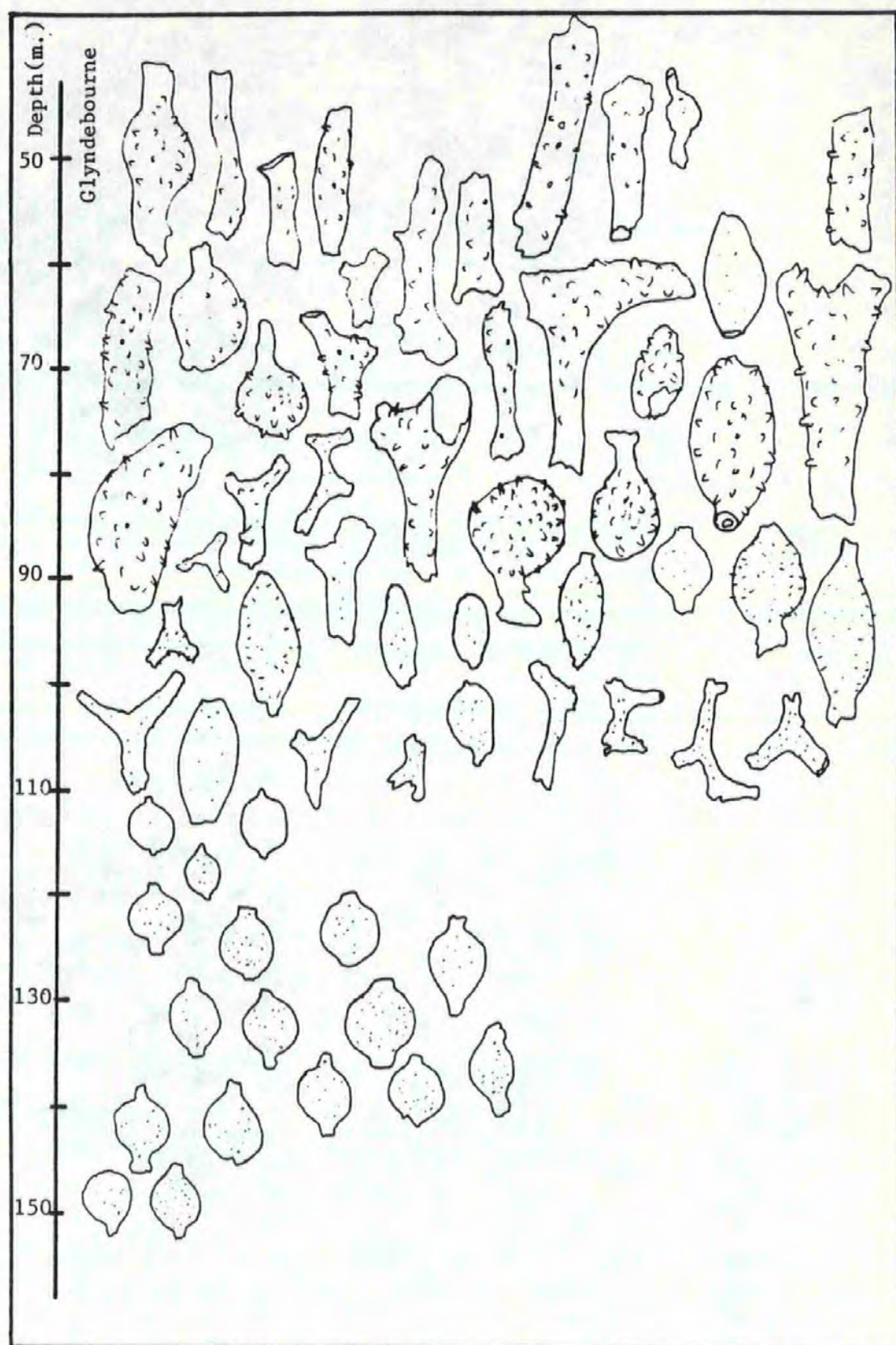
1950 Siphogenerina asperula (Chapman);Ten Dam:45

1975 Siphogenerina asperula (Chapman);Magniez-Jannin:238

Diagnosis: A coarsely hispid species of Siphogenerina.

|    | Length   | Width |
|----|----------|-------|
| 69 | 0.52m.m. | 0.14  |

Fig. 4:3 Variation in populations of the genus Ramulina in the Glyndebourne borehole.



Description: Test free, chambers globular, uniserial, rapidly increasing in size initially, later chambers similar in size; aperture produced on apertural neck, terminal, rounded; test surface strongly hispid.

Remarks: This species was originally described by Chapman (1896) from the Gault Clay at Folkestone where he recorded it ranging from Beds i to vii. It was regarded as zonally important by Price (1977b) who recorded it as ranging ubiquitously from the A.intermedius to the H.orbigny Subzone.

Stratigraphic conclusion: This species occurs sporadically in the Middle Albian and the lower part of the Upper Albian of southern England where it is of moderate, local, stratigraphic significance.

Superfamily DISCORBACEA Ehrenberg, 1838

Sub-family BAGGININAE Cushman, 1927

Genus Valvulineria Cushman, 1926

Type species: Valvulineria californica Cushman, 1926

Valvulineria parva Khan, 1950

(pl.12,figs.5-8)

1898 Rotalia soldanii d'Orbigny var. nitida Reuss;Chapman:9,pl.2,  
figs.2a-c

1950 Valvulineria parva Khan:275,pl.2,figs.12-14,19

1967 Valvulineria parva Khan;Magniez-Jannin:157,pl.1,figs.1-3a-c;  
pl.3,figs.1-3,6-9;pl.4,fig.1

1975 Valvulineria parva Khan;Magniez-Jannin:239,pl.16,figs.8-17

Diagnosis: A small species of Valvulineria.

|     | Diameter 1 | Diameter 2 |
|-----|------------|------------|
| 72a | 0.23m.m.   | 0.18       |
| 72b | 0.21       | 0.19       |
| 72c | 0.21       | 0.18       |
| 72d | 0.24       | 0.18       |

Description: Test free, trochospiral; periphery rounded; sutures radial; chambers gradually increase in size, involute; aperture an interiomarginal to extraumbilical slit, an apertural flap extends over part of the umbilicus; test biconvex, spiral side weakly convex, flattened, umbilical side strongly convex; six to eight chambers in the last whorl; test surface smooth.

Remarks: This species was described by Khan (1950) from Bed xii of the Gault Clay. It was described very thoroughly by Magniez-Jannin (1967, 1975) who initially divided it into five separate forms. In her later paper she divided this species into two chronoforms, one of which she recorded from the Lower Albian and the other from the Middle Albian.

Stratigraphic conclusion: This common species occurs throughout the Lower, Middle and lowest Upper Albian and is of limited stratigraphic value.

Valvulineria praestans Magniez-Jannin, 1975

(pl.12,figs.9-14)

1967 Valvulineria (Gyroidinoides) sp.2;Magniez-Jannin:160,pl.1,figs. 7-8a-b;pl.3,figs.16,17;pl.4,fig.4

1975 Valvulineria praestans Magniez-Jannin:244,pl.16,figs.32-44

Diagnosis: A large species of Valvulineria with a small, narrow, apertural flap.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 73a | 0.45m.m.   | 0.40       | 0.34   |
| 73b | 0.30       | 0.27       |        |
| 73c | 0.26       | 0.24       |        |
| 73d | 0.39       |            | 0.28   |
| 73e | 0.36       | 0.33       |        |
| 73f | 0.36       |            | 0.29   |

Description: Test free, trochospiral, biconvex; periphery rounded; sutures radial; chambers gradually increase in size, involute, inflated; in spiral view test sub-circular; in side view test subconical, spiral side weakly convex to flattened; umbilical side strongly convex; aperture an interiomarginal to extraumbilical,narrow,slit; a small apertural flap extends the length of the aperture; test surface smooth.

Remarks: This species was defined by Magniez-Jannin (1975) from the Vraconian of the Aube. She regarded it as characteristic of this horizon. It is here regarded as a chronospecies of V.parva.

Stratigraphic conclusion: A common species which occurs in the topmost Albian. It is of moderate stratigraphic value.

Superfamily SPIRILLINACEA Reuss, 1862

Family SPIRILLINIDAE Reuss, 1862

Sub-family PATELLININAE Rhumbler, 1906

Genus Patellina Williamson, 1858

Type species: Patellina corrugata Williamson, 1858

Patellina sp.A

(pl.1,fig.1)

|  | Diameter 1 | Diameter 2 |
|--|------------|------------|
|--|------------|------------|

|    |          |      |
|----|----------|------|
| 75 | 0.35m.m. | 0.34 |
|----|----------|------|

Remarks: A distinctive conical species which occurs sporadically in the Middle and Upper Albian. It is of limited stratigraphic value.

Superfamily GLOBIGERINACEA Carpenter, Parker & Jones, 1862

Family HETEROHELICIDAE Cushman, 1927

Sub-family GUEMBELITRINAE Montanaro Gallitelli, 1957

Genus Guembelitria Cushman, 1933

Type species: Guembelitria cretacea Cushman, 1933

Guembelitria harrisi Tappan, 1940

(pl.7,figs.7,8.)

1940 Guembelitria harrisi Tappan:115,pl.19,figs.2a,b

1943 Guembelitria harrisi Tappan;Tappan:507,pl.81,figs.13,14a,b

1972 Guembelitria cenomana (Keller);Gawor-Biedowa:60,pl.5,fig.4

1975 Guembelitria harrisi Tappan;Price:630,pl.1,figs.3,4,text figs.

4,5

1975 Guembelitria harrisi Tappan;Magniez-Jannin:247,pl.20,figs.16,17

1977 Guembelitria harrisi Tappan;Carter & Hart:26,pl.2,fig.11

Diagnosis: A small, smooth, species of Guembelitria.

|    | Length   | Width |
|----|----------|-------|
| 79 | 0.16m.m. | 0.1   |
| 80 | 0.13     | 0.08  |

Description: Test free, triserial throughout; chambers inflated, globular; sutures distinct,depressed; aperture an interiomarginal arch at base of last formed chamber; chambers gradually increase in size, greatest width at apertural end; test subtriangular in cross section, test sub-triangular in side view; bluntly pointed at umbilical end; test surface smooth.

Remarks: This distinctive species has been recorded by many authors from the Anglo-Paris Basin. It was recorded in clays as young as L.lyelli subzonal age from the Aube by Price (1975) and from the A.intermedius Subzone of Germany. Carter & Hart (1977) recorded it first appearing in southern England in the Middle Albian but not becoming abundant until the Upper Albian. In the present study it

was only recorded from the S.dispar Zone.

Gawor-Biedowa (1972) stated that the Polish specimens conformed in all respects to the holotype of G.cenomana (Keller, 1935), and that this species only differs from G.harrisi in the slower rate of inflation of chambers which it exhibits. Carter & Hart (1977) noted this problem and suggested that since the figured specimen of Gawor-Biedowa falls within the intra-specific range of G.harrisi the two species are probably synonymous. The present author agrees with this view but leaves, as Carter & Hart (1977) did, this matter for further investigation.

Stratigraphic conclusion: This species occurs in the Middle and Upper Albian of northwest Europe. In southern England it first occurs abundantly in the S.dispar Zone while in the Aube it occurs in abundance in the H.dentatus Zone. It is of moderate stratigraphic significance.

Sub-family HETEROHELICINAE Cushman, 1927

Genus Heterohelix Ehrenberg, 1843

Type species: Spiroplecta americana Ehrenberg, 1844

Heterohelix moremani (Cushman, 1938.)

(pl.7, figs. 3,5,6,10.)

1938 Guembelina moremani Cushman:10, pl.2, figs.1-3

1940 Guembelina washitensis Tappan:115, pl.19, fig.1

1946 Guembelina moremani Cushman; Cushman:103, pl.46, figs.15,16(non.17)

1967 Heterohelix moremani (Cushman); Bandy:22, text fig.11

1967 Heterohelix washitensis (Tappan); Bandy:22, text fig.12(1A)

1972 Heterohelix moremani (Cushman); Michael:208, pl.6, fig.12

1972 Heterohelix washitensis (Tappan); Gawor-Biedowa:61, pl.5, figs.3a,b

1977 Heterohelix moremani (Cushman); Masters:346, pl.2, fig.1

1977 Heterohelix moremani (Cushman); Carter & Hart:26, pl.2, fig.17



Diagnosis: A small, smooth, species of Heterohelix.

|    | Height   | Width | Thickness |
|----|----------|-------|-----------|
| 76 | 0.37m.m. | 6.2   |           |
| 77 | 0.24     | 0.1   | 0.07      |
| 78 | 0.22     | 0.1   | 0.06      |

Description: Test free, small, biserial; chambers inflated, globular; sutures depressed; aperture a low interiomarginal arch; chambers gradually increasing in size, greatest width at apertural end; test sub-ovate in apertural view, sub-triangular in side view; umbilical margin bluntly pointed; test surface smooth.

Remarks: This distinctive species is the oldest of the genus (Masters, 1977). It was originally described by Cushman (1938) and was regarded as a senior synonym of G.washitensis Tappan, 1940 by Masters (1977). Both Price (1977b) and Carter & Hart (1977) regarded this species as first appearing in the Middle Albian.

Stratigraphic conclusion: A common species which appears earlier in the Aube than in southern England where it is not abundant until the S.dispar Zone. It is of moderate stratigraphic value.

Family PLANOMALINIDAE Bolli, Loeblich & Tappan, 1957

Genus Globigerinelloides Cushman & Ten Dam, 1948

Type species: Globigerinelloides algeriana Cushman & Ten Dam, 1948

Globigerinelloides bentonensis (Morrow, 1934.)

(pl.7,figs.1,2,4.)

?1927 Anomalina eaglefordensis Moreman:99,pl.16,fig.9

1934 Anomalina bentonensis Morrow:201,pl.30,figs.4a,b

1940 Anomalina bentonensis Morrow;Cushman:28,pl.5,figs.3a,b

1940 Planulina eaglefordensis (Moreman);Cushman:32,pl.6,figs.4,5

- 1946 Anomalina bentonensis Morrow; Cushman:154, pl. 63, figs. 7a, b
- 1946 Planulina eaglefordensis (Moreman); Cushman:156, pl. 64, figs. 8a-c
- 1961 Globigerinelloides bentonensis (Morrow); Loeblich & Tappan:267,  
pl. 2, figs. 8-10
- 1961 Globigerinelloides eaglefordensis (Moreman); Loeblich & Tappan:  
268, pl. 2, figs. 3a-7b
- 1965 Globigerinelloides bentonensis (Morrow); Eicher:904, pl. 16, fig. 10
- 1972 Globigerinelloides bentonensis (Morrow); Gawor-Biedowa:63, pl. 6,  
figs. 7a-c
- 1975 Globigerinelloides bentonensis Eicher; Price:640, pl. 2, figs. 8-10
- 1975 Globigerinelloides eaglefordensis (Moreman); Magniez-Jannin:249,  
pl. 20, figs. 18-21
- 1977 Globigerinelloides bentonensis (Morrow); Carter & Hart:27, pl. 1,  
fig. 11; pl. 2, figs. 19, 20
- 1977 Globigerinelloides bentonensis (Morrow); Masters:464, pl. 10, figs.  
2, 3

Diagnosis: A weakly inflated species of Globigerinelloides with a smooth test surface and globular chambers.

|    | Diameter 1 | Diameter 2 | Thickness |
|----|------------|------------|-----------|
| 81 | 0.23m.m.   | 0.23       | 0.12      |
| 82 | 0.32       | 0.23       | 0.13      |
| 83 | 0.22       | 0.28       | 0.11      |

Description: Test free, planispiral, bi-umbilicate; chambers inflated, gradually increasing in size, approximately eight in last whorl; surface is smooth with large simple pores which are low in density; sutures depressed, curved; aperture a broad low interior-marginal equatorial arch with distinct apertural flap, relict flaps are present along inner margins of last whorl.

Remarks: This species has been recorded from most of north-western Europe. It was recorded by Gawor-Biedowa (1972) from the

Upper Albian of Poland and by Magniez-Jannin (1975) from the S. dispar Zone of the Aube. Price (1975, 1977b) regarded this species as first occurring in the C. auritus Subzone and ranging into the Cenomanian. Carter & Hart (1977) also regarded it as zonally significant and recorded it first occurring in their Zone 5a and ranging into the Cenomanian. Both Price and Carter & Hart regarded this as a 'Boreal' species. In the present study this species was recorded first appearing at the base of the M. rostratum Subzone and ranging into the Cenomanian. It was only recorded in abundance in the M. rostratum Subzone. Masters (1977) recorded this species extensively from the Tethyan realm but not from England. He only recorded G. cushmani (Tappan, 1943) from England. These species may prove, with further research, to be synonymous, but this subject is here left open for further review.

Stratigraphic conclusion: A very important stratigraphic marker that only occurs abundantly in the M. rostratum Subzone. It occurs sporadically in higher beds.

Family ROTALIPORIDAE Sigal, 1958

Sub-family HEDBERGELLINAE Loeblich & Tappan, 1961

Genus Hedbergella Brönnimann & Brown, 1958

Type species: Anomalina lorneiana d'Orbigny var. trochoidea Gandolfi, 1942

This genus has a confused history with both early and recent authors preferring the genus Globigerina d'Orbigny, 1826. This generic discussion relates to the change in fauna across the Cretaceous/Tertiary boundary and is not within the scope of this thesis. The genus Hedbergella is therefore retained for Cretaceous species.

Masters (1977) outlined the philosophical and practical problems associated with the definition of planktonic species. He thought that most of the problems stem from two areas:-

- a) A lack of comparison to recent populations.
- b) A lack of understanding of the shallow epicontinental sea environment.

For these reasons the species concept utilised for the following planktonic species is based on that of Bé (1977) and Boltovskoy & Wright (1976). These authors have described very thoroughly Recent planktonic populations and have also clearly outlined their intraspecific variety.

Hedbergella delrionensis (Carsey, 1926)

(pl.8, figs.5-16; pl.9, figs.

1-11; pl.10, figs.1-6.)

- 1896 Globigerina aequilateralis Brady; Chapman:587, pl.13, fig.7
- 1896 Globigerina bulloides d'Orbigny; Chapman:588, pl.13, fig.4
- 1896 Globigerina cretacea d'Orbigny; Chapman:588, pl.13, figs.5,6
- 1926 Globigerina cretacea d'Orbigny:var.delrionensis Carsey:43
- 1937 Globigerina infracretacea Glaessner:28, text fig.1
- 1940 Globigerina cretacea d'Orbigny; Tappan:121, pl.19, figs.11a-c
- 1947 Globigerina infracretacea Glaessner; Ten Dam:27
- 1948 Globigerina portsdownensis Williams-Mitchell; 96, pl.8, figs.4a-c
- 1950 Globigerina infracretacea Glaessner; Ten Dam:54
- 1959 Praeglobotruncana (Hedbergella) delrionensis (Carsey); Banner &  
Blow:8
- 1960 Globigerina infracretacea Glaessner; Moullade:136, pl.2, figs.  
18-20
- 1961 Globigerina infracretacea Glaessner; Loeblich & Tappan:276
- 1961 Hedbergella brittonensis Loeblich & Tappan:274, pl.4, figs.1-8

- 1961 Hedbergella portsdownensis (Williams-Mitchell); Loeblich & Tappan:  
277 pl.5, figs.3a-c
- 1966 Hedbergella infracretacea (Glaessner); Glaessner(emend.):179, pl.  
1, figs.1-3
- 1967 Globigerina portsdownensis Williams-Mitchell; Bandy:8, text. fig.3
- 1967 Hedbergella brittonensis Loeblich & Tappan; Fuchs:331, pl.18, figs.  
1a-c
- 1967 Hedbergella infracretacea (Glaessner); Fuchs:331, pl.17, figs.13a-c
- 1969 Hedbergella delrionensis (Carsey); Hermes:47
- 1969 Hedbergella infracretacea (Glaessner); Hermes:48, pl.5, figs.101,  
102
- 1969 Hedbergella sp.aff. H.infracretacea (Glaessner); Hermes:46, pl.1,  
figs.19-24
- 1969 Hedbergella sp.cf.H.planispira (Tappan); Hermes:45, pl.1, figs.  
25-27
- 1972 Hedbergella brittonensis Loeblich & Tappan; Gawor-Biedowa:67, pl.8,  
figs.1a-c, 2a-c
- 1972 Hedbergella infracretacea (Glaessner); Gawor-Biedowa:69, pl.6,  
figs.8a-c
- 1972 Hedbergella delrionensis (Carsey); Michael:210, pl.2, figs.1-3
- 1973 Hedbergella delrionensis (Carsey) delrionensis (Carsey);  
Baccaert:544, pl.2, fig.3
- 1973 Hedbergella delrionensis (Carsey) brittonensis (Loeblich &  
Tappan); Baccaert:545, pl.2, fig.2
- 1973 Hedbergella sp.cf.delrionensis (Carsey) delrionensis (Carsey);  
Baccaert:546, pl.2, fig.4
- 1973 Hedbergella sp.cf.H.delrionensis (Carsey) brittonensis (Loeblich  
& Tappan); Baccaert:546
- 1973 Hedbergella sp.aff.H.infracretacea Glaessner (Moullade);  
Baccaert:547, pl.3, figs.1,3

- 1975 Hedbergella delrionensis (Carsey); Longoria:54, pl.10, figs.1-12;  
pl.13, figs.3-5, 15-18
- 1975 Hedbergella infracretacea (Glaessner); Longoria:59, pl.13, fig.9
- 1975 Hedbergella delrionensis (Carsey); Magniez-Jannin:250, pl.7, figs.  
1-46
- 1975 Hedbergella infracretacea (Glaessner); Magniez-Jannin:256, pl.18,  
figs.13-34
- 1975 Hedbergella sp. Magniez-Jannin:258, pl.19, figs.1-11
- 1977a Hedbergella brittonensis (Loeblich & Tappan); Price:519, pl.61,  
figs.1-3
- 1977a Hedbergella delrionensis (Carsey); Price:519, pl.61, figs.4-6
- 1977a Hedbergella infracretacea (Glaessner); Price:519, pl.61, figs.7-9
- 1977 Hedbergella brittonensis (Loeblich & Tappan); Carter & Hart:  
31, pl.4, figs.13-15
- 1977 Hedbergella delrionensis (Carsey); Carter & Hart:35, pl.4, figs.1-3
- 1977 Hedbergella infracretacea (Glaessner); Carter & Hart:35, pl.3, figs.  
18-20
- 1977 Globigerina delrionensis Carsey; Masters:454, pl.20, figs.4,5

Diagnosis: A large species of Hedbergella which is trochospirally coiled and has a hispid test surface.

|     | Diameter 1 | Diameter 2 |
|-----|------------|------------|
| 96  | 0.21m.m.   | 0.17       |
| 97  | 0.18       | 0.16       |
| 98  | 0.19       | 0.16       |
| 99  | 0.24       | 0.21       |
| 100 | 0.22       | 0.17       |
| 101 | 0.20       | 0.15       |
| 102 | 0.21       | 0.16       |
| 103 | 0.19       | 0.15       |
| 104 | 0.21       | 0.17       |

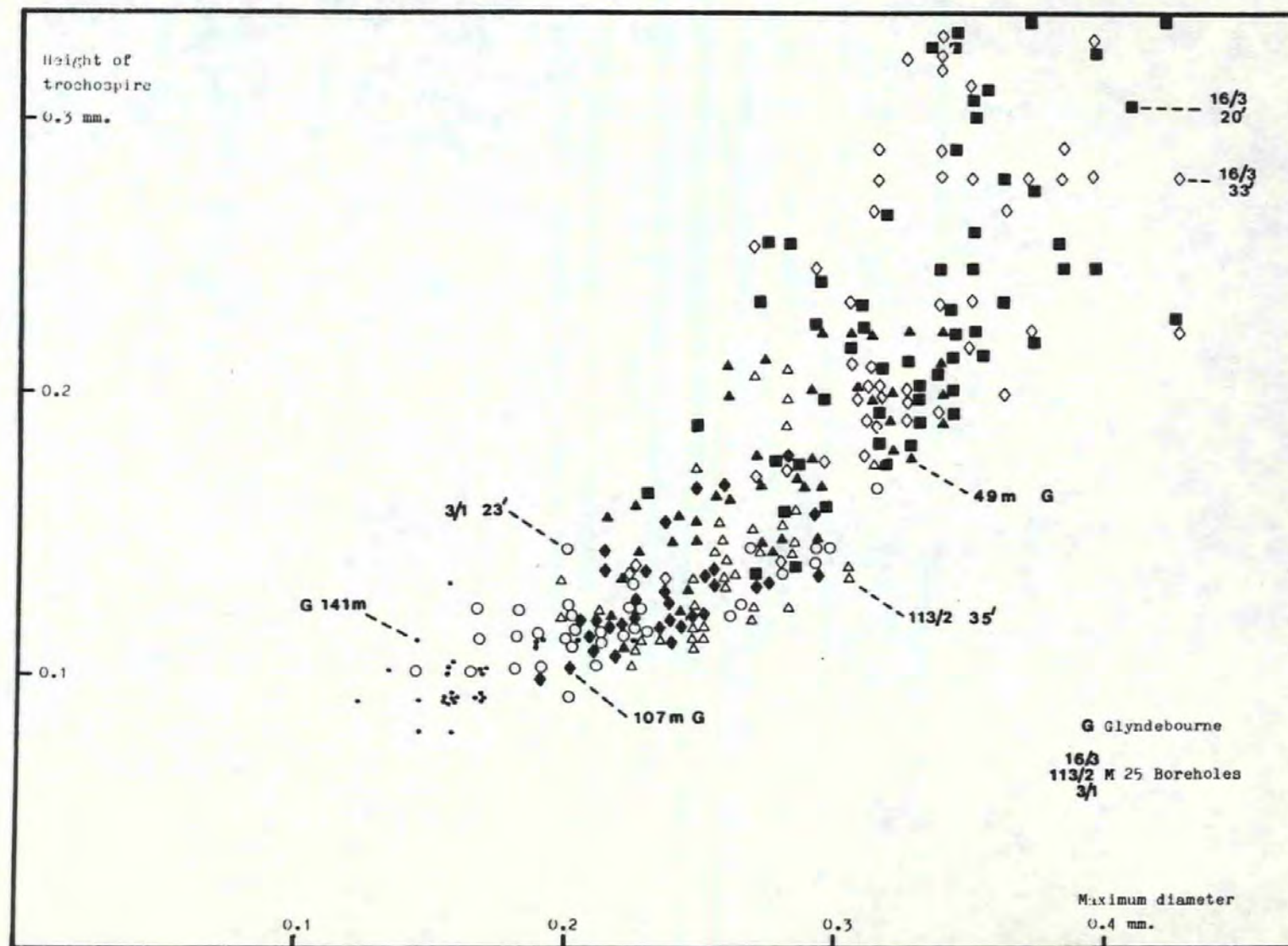
|     |      |      |
|-----|------|------|
| 105 | 0.20 | 0.17 |
| 106 | 0.25 | 0.20 |
| 107 | 0.26 | 0.21 |
| 108 | 0.38 | 0.32 |
| 109 | 0.36 | 0.31 |
| 110 | 0.37 | 0.31 |
| 111 | 0.39 | 0.32 |
| 112 | 0.38 | 0.34 |
| 113 | 0.43 | 0.38 |
| 114 | 0.44 | 0.34 |

**Description:** Test free, chambers arranged in a trochospire with four to six in the last whorl; chambers inflated, globular, normally with a coarsely hispid surface; test wall perforated by a large number of simple pores; umbilicus depressed; sutures depressed; in spiral view early whorls weakly raised; aperture an interior-marginal, extraumbilical arch with a spatulate lip extra-umbilically; chambers gradually increase in size.

**Variation:** This is a very variable species. The size of the test, height of trochospire, number of chambers, hispidity, pore diameter and prominence of the apertural flap are all variable. In southern England the size and hispidity of populations generally increases through the Albian (fig. 4:4). The height of trochospire, which is generally variable throughout the Albian, controls the number of chambers in the last whorl.

This therefore is also very variable throughout the Albian. The pore diameter increases during the lower part of the Upper Albian. During this time period many specimens were recorded with 'counter-sunk' and not simple pores. The variability of this species is discussed further in relation to the taxonomy and also to the palaeoenvironment (Chapter 7).

Fig. 4:4 The maximum width/height ratios of a series of populations of H. delrionenes. This illustrates the increase in size and the gradational nature of the size changes during the Albian.





Remarks: This species has been thoroughly discussed by a large number of recent authors. Previously only Masters (1977) has regarded the species H. delrionensis and H. infracretacea Glaessner, 1937 as synonymous. Here they are regarded as end members of the same species.

Hofker (1960, 1961) suggested evolutionary trends which might link these two species, H. infracretacea being the older stock from which younger and more advanced forms evolved. Indeed Glaessner (1966) acknowledged this possibility and stated that in future H. infracretacea (Glaessner, 1937) might be given the status of a chronosubspecies of H. delrionensis (Carsey, 1926). Both Maslakova (1963) and Masters (1977) regarded these two species as synonymous and while the former author did not qualify this statement the latter, while giving a full synonymy and discussing the philosophy of this statement, offered no quantitative evidence for it.

The size of successive populations has been shown (fig.4:4) to vary during the Middle and Upper Albian. These populations show a general increase in size which is most marked during the Upper Albian. The variation of successive populations has been plotted with regard to the change in size of specimens and height of trochospire (fig.4:4). This illustrates the general increase in size of the populations and shows that each population is gradational between high and low spired forms. All the populations are dominated by lower spired forms which have previously been called H. delrionensis. The higher spired forms have previously been called H. infracretacea. In the highest Albian the populations are even more variable in the height/width ratio and many of these specimens have been called H. brittonensis. It has generally been stated that H. infracretacea becomes extinct before this horizon. These two figures illustrate the gradational nature of the change in the hedbergellid population and that any

distinction of species within this population is completely arbitrary. None of the taxonomically significant morphological features can be used to consistently separate species within this plexus.

The variation of the pore diameter and hispidity have been illustrated in the plates (pl.9, figs.1-4; pl.10, figs.1-6). These features have been shown by Bé to reflect water temperature and/or the depth habitat of a given species and they have already been shown to vary greatly within the Albian. These changes are discussed in relation to their palaeoecological significance in the concluding chapters where it has been interpreted that they are a direct function of environmental change.

The changes in the population of H.delrionensis are related to the occurrence and the abundance of other planktonic species in the Albian. The specimens associated with F.washitensis are generally smoother and tend to possess enlarged pores. During this time interval H.planispira (Tappan, 1940) tends to occur in greater abundance. This change in morphology and abundance (figs. 8:11, 8,12) of H.delrionensis has been interpreted as indicating that during this time interval H.delrionensis occurred near to its ecological limit, the lack of hispidity and enlarged pores being an adaptive function to warmer water conditions. Specimens illustrating "Kummerform" growth have also been recorded.

The growth of this species varies. In the Middle Albian the chamber walls are generally thinly calcified and tend to lack coarse hispidity. In the Upper Albian the test wall tends to be thicker and the hispidity stronger. The last formed chamber is often less hispid than the earlier formed chambers but in the majority of specimens is coarsely hispid. This indicates that much of the chamber calcification occurs during the growth of the last formed chamber.

The coiling ratio of this species (fig. 4:6) is approximately fifty percent sinistral and fifty percent dextral throughout the Middle and Upper Albian, indicating that this species shows no temperature control of the coiling ratio as seen in many recent species of planktonic foraminifera (Bé, 1977).

Previous authors have regarded the first occurrence of this species and the various forms of this species as stratigraphically significant. In this study the change in gross morphology of this species is regarded as of major stratigraphic significance. The first appearance of this species must be extremely diachronous since it has been recorded commonly from the Aptian and thus the first occurrence can only be of very local stratigraphic significance.

This species can be distinguished from the other Albian species of Hedbergella, Hedbergella planispira, by its larger size, fewer chambers in the last whorl and the generally higher trochospire.

Stratigraphic conclusion: The first appearance of this species in southern England is of minor stratigraphic significance. The change in the bulk population of this species is of major stratigraphic significance.

Hedbergella planispira (Tappan, 1940)

(pl.8, figs.1-4.)

- 1940 Globigerina planispira Tappan:120, pl.19, fig.12
- 1943 Globigerina planispira Tappan; Tappan:513, pl.83, fig.3
- 1961 Hedbergella planispira (Tappan); Loeblich & Tappan:276, pl.5,  
figs.4-11
- 1965 Hedbergella planispira (Tappan); Eicher:905, pl.106, figs.1a-c
- 1966 Hedbergella(Hedbergella)planispira (Tappan); Moullade:93, pl.8,  
figs.4-5
- 1967 Hedbergella planispira (Tappan); Fuchs:332, pl.8, figs.2a-c

- 1972 Hedbergella planispira (Tappan); Gawor-Biedowa: 70, pl. 5, figs. 8a-c
- 1973 Hedbergella planispira (Tappan); Baccaert: 546, pl. 1, figs. 3-4
- 1975 Hedbergella planispira (Tappan); Longoria: 64, pl. 20, fig. 4; pl. 23, figs. 2, 3
- 1975 Hedbergella planispira (Tappan); Magniez-Jannin: 254, pl. 18, figs. 1-12
- 1977a Hedbergella planispira (Tappan); Price: 520, pl. 61, figs. 10-12
- 1977 Hedbergella planispira (Tappan); Carter & Hart: 36, pl. 4, figs. 4-6
- 1977 Hedbergella planispira (Tappan); Longoria & Gamper: 204
- 1977 Globigerina planispira Tappan; Masters: 424, pl. 24, figs. 2, 3, 5

Diagnosis: A small, planispiral, species of Hedbergella.

|    | Diameter 1 | Diameter 2 | Height |
|----|------------|------------|--------|
| 92 | 0.18m.m.   |            | 0.08   |
| 93 | 0.19       | 0.15       |        |
| 94 | 0.19       | 0.15       |        |
| 95 | 0.17       | 0.14       |        |

Description: Test free; chambers arranged in a low trochospire with five to seven chambers in the last whorl; chambers inflated, globular; test surface finely hispid with a large number of small pores; umbilicus depressed; in umbilical view test rounded; in spiral view early whorls slightly depressed; test planispiral; aperture an interiomarginal, extraumbilical arch, with a spatulate lip extraumbilically; chambers gradually increase in size.

Variation: The variability of this species is limited. The number of chambers in the last whorl does vary as does the height of the trochospire and test size of some specimens (fig. 45). This species is generally more consistent in morphology than other species of the genus Hedbergella.

Fig. 4:5 Variation in the size of H.planispira compared to that of H.delrionensis.

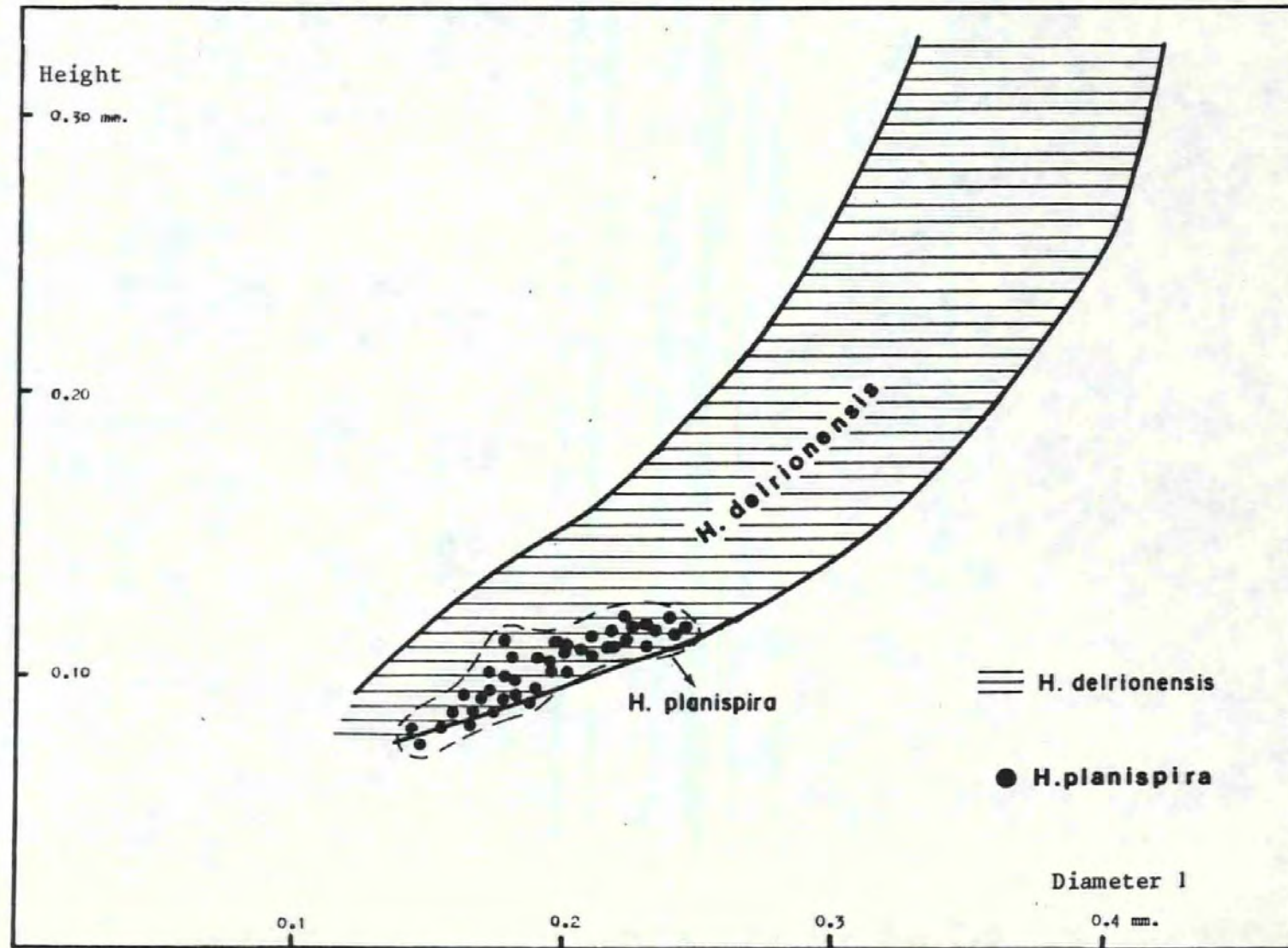




Fig. 4:6 The coiling ratio in both H. delrionensis and H. planispira ( based on counts of approximately 100 specimens per sample ) during the Middle and Upper Albian.

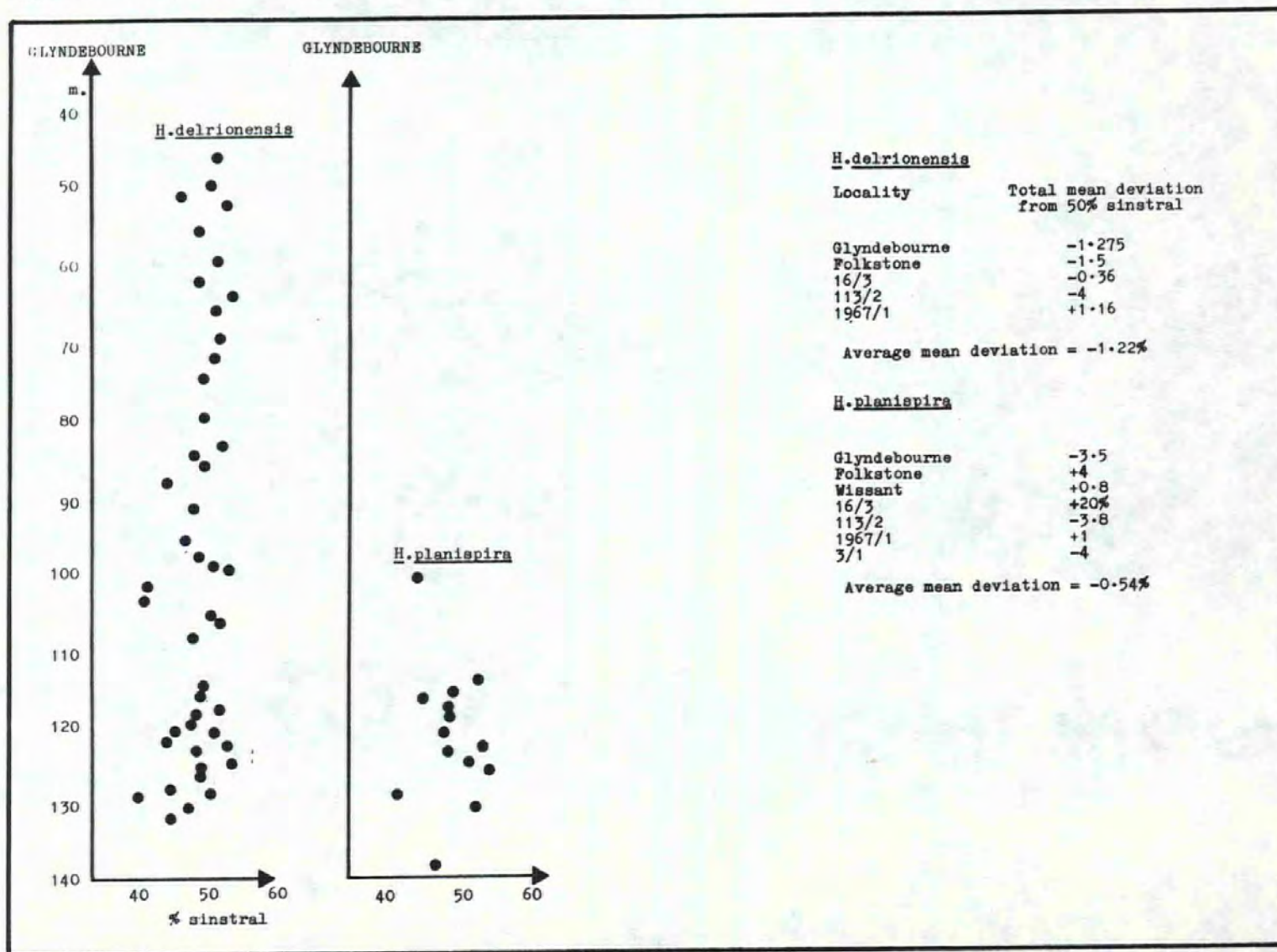
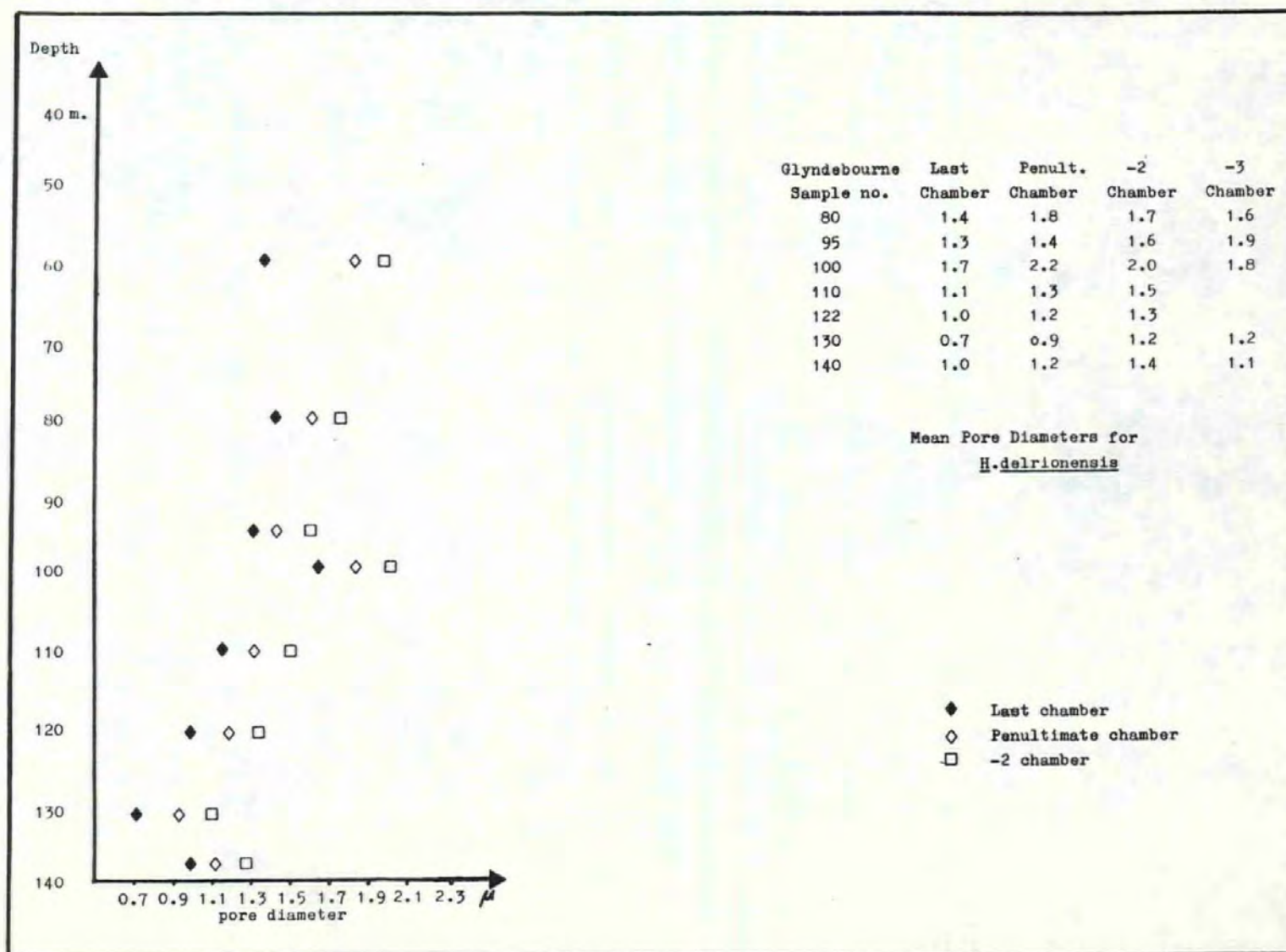


Fig. 4:7 The variation in the mean pore diameter of specimens of H.delrionensis in the Middle and Upper Albian ( based on the measurement of 10 specimens per sample ).



Remarks: This species can easily be distinguished from H. delrionensis by its size, height of trochospire, and the number of chambers in the last whorl. The variation in size of this species has been recorded (fig.4:5) as has the change in the coiling ratio. The size of this species is relatively consistent while the coiling ratio is approximately fifty percent sinistral/fifty percent dextral (fig. 4:6) throughout the Middle and Upper Albian, indicating that this species shows no temperature control of the coiling ratio as seen in many recent species of planktonic foraminifera (Bé, 1977).

This species has not been regarded as of major stratigraphic significance by previous authors although both Price (1977b) and Carter & Hart (1977) did regard its first appearance as significant. This species, similarly to H. delrionensis, has been recorded from the Aptian and its first appearance during the Albian can, therefore, only be of local stratigraphic significance. The relative abundance of this species is very variable in the Albian of southern England. This variation is regarded as of both stratigraphic and palaeo-ecological significance and is discussed further in the concluding chapters.

Stratigraphic conclusion: This species occurs abundantly in the Middle and Upper Albian of southern England where the variation in abundance is regarded as of stratigraphic significance.

Genus Favusella Michael, 1972

Type species: Globigerina washitensis Carsey, 1926

Favusella washitensis (Carsey, 1926)

(pl.7, figs.9,11-16;

pl.10, figs.7-10.)

1926 Globigerina washitensis Carsey:44, pl.7, fig.10; pl.8, fig.2

1940 Globigerina washitensis Carsey; Tappan:122, pl.19, figs.13a-c



- 1961 Hedbergella washitensis (Carsey); Loeblich & Tappan: 278, pl. 4,  
figs. 9-11
- 1967 Hedbergella washitensis (Carsey); Bandy: 8, text fig. 3
- 1973 Favusella hiltermanni (Loeblich & Tappan); Michael: 213, pl. 6, fig. 8
- 1973 Favusella nitida Michael: 214, pl. 3, figs. 10-12
- 1973 Favusella orbiculata Michael: 214, pl. 4, figs. 1-3
- 1973 Favusella pessagnoii Michael: 214, pl. 4, figs. 4-6
- 1973 Favusella quadrata Michael: 215, pl. 4, figs. 7-9
- 1973 Favusella scitula Michael: 215, pl. 4, figs. 10-12
- 1973 Favusella washitensis (Carsey); Michael: 215, pl. 5, figs. 1-3
- 1973 Favusella wenoensis Michael: 216, pl. 5, figs. 4-9; pl. 7, figs. 3, 4
- 1977 Hedbergella washitensis (Carsey); Carter & Hart: 37, pl. 2, fig. 16
- 1977 Favusella confusa Longoria & Gamper: 204, pl. 3, figs. 4-6, 10-12;  
pl. 4, figs. 25-27
- 1977 Favusella hedbergellaeformis Longoria & Gamper: 207, pl. 4, figs.  
1-3, 7-9
- 1977 Favusella nitida Michael; Longoria & Gamper: 207, pl. 3, figs. 7-9
- 1977 Favusella papagayosensis Longoria & Gamper: 203, pl. 4, figs. 16-21;  
pl. 5, figs. 16-21
- 1977 Favusella planata Longoria & Gamper: 207
- 1977 Favusella scitula Michael; Longoria & Gamper: 208, pl. 4, figs. 13-15,  
22-24
- 1977 Favusella voloshinae Longoria & Gamper: 208, pl. 3, figs. 1-3, 16-18
- 1977 Favusella washitensis (Carsey); Longoria & Gamper: 208, pl. 3, figs.  
13-15; pl. 4, figs. 4-6; pl. 5, figs. 22-24
- 1977 Globigerina washitensis Carsey; Masters: 477, pl. 25, fig. 4; pl. 26,  
figs. 1-3

Diagnosis: A large species of Favusella which is coarsely reticulate and has normal pores of small diameter.

|    | Diameter 1 | Diameter 2 |
|----|------------|------------|
| 84 | 0.28m.m.   | 0.23       |
| 85 | 0.28       | 0.22       |
| 86 | 0.31       | 0.29       |
| 87 | 0.29       | 0.29       |
| 88 | 0.32       | 0.27       |
| 89 | 0.36       | 0.34       |
| 90 | 0.36       | 0.25       |

Description: Test free; chambers arranged in a high trochospire with four or five in the last whorl; chambers inflated, globular, surface strongly reticulate; umbilicus depressed, sutures depressed; in spiral view early chambers weakly raised, later chambers strongly raised; aperture an interiomarginal, extraumbilical arch, no apertural lip visible; wall punctate with a large number of small normal pores.

Variation: This is a very variable species. The height of the trochospire is variable, and while some specimens are nearly planispiral others are very high spired with the last chamber almost overlapping the umbilicus. The number of chambers in the last whorl and the rate of inflation of the chambers vary in relation to the height of the trochospire. The degree of reticulation is also very variable and while some specimens are coarsely reticulate, others are very coarsely rugose. The variation of this species is illustrated (pl.10, figs. 7-10).

Remarks: This distinctive reticulate species has a very confused history. Few authors have recognised the amount of intra-specific variety which this species illustrates and this has led the creation of many new species which have no stratigraphic or taxonomic significance. These species are therefore regarded as synonymous. This species has also been retained in the genus

Hedbergella by several recent authors (Price, 1977a; Carter & Hart, 1977). However, the pores are significantly smaller than those in species of the genus Hedbergella, and this species is therefore retained in the separate genus Favusella.

In southern England this species was recorded from the upper Middle and lower Upper Albian while Magniez-Jannin (1975) recorded it as of very variable abundance in the Middle Albian of the Aube. She noted that it occurred more frequently in beds with higher carbonate concentration.

This species has been recorded extensively (Masters, 1977) from Europe and North America. It has also been recorded from South America, Africa and Japan. It appears to be a dominantly Tethyan form.

Carter & Hart (1977) noted that this species also occurs immediately preceding the mid-Cenomanian non sequence in southern England. They also observed that this later occurrence coincided with a change in the macrofauna which might be indicative of a change in the environment.

This species has only been recorded as occurring sporadically in the Albian and Cenomanian of the Anglo-Paris Basin. It is associated with the Tethyan influence which is generally reflected in the total fauna.

The coarse reticulation and the small pore size that this species exhibits has resulted in a relatively heavy test. The additional weight of the test, when compared to species of the genus Hedbergella, must have resulted from either a different (deeper) depth habitat of this species or a better mechanism for keeping this species afloat near the surface.

Stratigraphic conclusion: A sporadically occurring species which is limited in distribution to the Anglo-Paris Basin; of moderate stratigraphic significance.

Superfamily CASSIDULINACEA d'Orbigny, 1839

Family PLEUROSATOMELLIDAE Reuss, 1860

Sub-family PLEUROSATOMELLINAE Reuss, 1860

Genus Pleurostomella Reuss, 1860

Type species: Dentalina subnodosa Reuss, 1851

Pleurostomella reussi Berthelin, 1880

(pl.6, fig.12.)

1880 Pleurostomella reussi Berthelin:28, pl.1, figs.10a,b,11,12

1880 Pleurostomella obtusa Berthelin:29, pl.1, figs.9a,b

1892b Pleurostomella obtusa Berthelin;Chapman:757, pl.12, figs.13a,b

1892b Pleurostomella alternans Schwager;Chapman:758, pl.12, figs.14a,b

1933 Pleurostomella alternans Schwager;Eichenberg:18, pl.5, fig.4

1950 Pleurostomella reussi Berthelin;Ten Dam:44, pl.3, fig.15

1954 Pleurostomella obtusa Berthelin;Bartenstein:41

1967 Pleurostomella reussi Berthelin;Fuchs:332, pl.18, figs.5,6a,b

1975 Pleurostomella obtusa Berthelin;Magniez-Jannin:270, pl.15, figs.

14-20

Diagnosis: A species of Pleurostomella with a projecting hood over the aperture.

|     | Length   | Width |
|-----|----------|-------|
| 115 | 0.59m.m. | 0.1   |

Description: Test free, elongate; later chambers uniserial, circular in cross section; sutures in early part oblique, later sutures at right angles to test axis; aperture large with a projecting hood; test surface smooth.

Remarks: This distinctive species was thoroughly documented by Magniez-Jannin (1975) who recorded it ranging from the uppermost Lower Albian to the Vraconian.

Stratigraphic conclusion: A sporadically occurring, generally

rare species which ranges through most of the Albian. It is of limited stratigraphic value.

Family ANOMALINIDAE Cushman, 1927

Sub-family ANOMALININAE Cushman, 1927

Genus Gavelinella Brotzen, 1942

Type species: Discorbina pertusa Marsson, 1878

Gavelinella baltica Brotzen, 1942

(pl.11,figs.3,7,10,13.)

1942 Gavelinella baltica Brotzen:50,pl.1,fig.7

1972 Gavelinella (Gavelinella) baltica Brotzen;Gawor-Biedowa:125,pl.  
17,figs.5a-c

1977a Gavelinella baltica Brotzen;Price:514,pl.60,figs.3,4

1977 Gavelinella baltica Brotzen;Carter & Hart:46,pl.1,figs.36-38

Diagnosis: A species of Gavelinella with a bluntly rounded periphery.

|     | Diameter 1 | Diameter 2 | Thickness |
|-----|------------|------------|-----------|
| 116 | 0.68       | 0.59       | 0.31      |
| 117 | 0.66       | 0.51       | 0.32      |
| 118 | 0.65       | 0.58       |           |

Description: Test free, biconvex, spiral side less convex than umbilical side; chambers arranged in a low trochospire, involute; periphery sharply rounded in spiral view, subcircular; sutures broadly raised, curved; aperture a low interiomarginal slit extending from near periphery to umbilicus; apertural face flattened, sub-triangular in apertural view; umbilicus depressed, chambers gradually increase in size, ten to eleven in the last whorl; in umbilical view short relict slits are present along the margins of the sutures; chamber surface smooth.

Variation: The size of specimens and the inflation of the

chambers increases during the Upper Albian.

Remarks: This species was originally described by Brotzen (1942) from the Cenomanian. He distinguished it from G. ammonoides (Reuss, 1845) which he also recorded from the Cenomanian. Subsequent authors have confused this species and only Price (1977a) and Carter & Hart have produced viable interpretations, but they failed to agree as to the total range of it in the Albian. Price (1977a) recorded G. cf. baltica from the D. niobe Subzone to the Cenomanian and G. baltica from the M. perinflatum Subzone to the Cenomanian. Carter & Hart (1977) recorded 'primitive' forms in their Zone 6a. These early forms of G. baltica occur throughout the Upper Albian and can be easily distinguished from G. intermedia (Berthelin, 1880) in the S. dispar Zone by their inflated latter chambers, sharply rounded periphery and raised sutures. They also lack an umbilical boss. In the M. inflatum Subzone this species is similar to, and difficult to separate from, G. intermedia.

Stratigraphic conclusion: This species is abundant in the uppermost Albian of southern England. In earlier strata it is difficult to separate from specimens of G. intermedia and it is therefore of only limited stratigraphic value.

Gavelinella cenomanica (Brotzen, 1942)

(pl. 11, figs. 5, 6, 8, 12.)

1942 Cibicidoides (Cibicides) cenomanica Brotzen: 54, pl. 2, figs. 2a-c

1966 Gavelinella cenomanica (Brotzen); Michael: 436, pl. 5, figs. 16, 17

1972 Gavelinella cenomanica (Brotzen); Gawor-Biedowa: 126, pl. 17, figs.

4a-c

1977a Gavelinella cenomanica (Brotzen); Price: 516, pl. 60, figs. 5, 6

1977 Gavelinella cenomanica (Brotzen); Carter & Hart: 46, pl. 1, figs. 46, 47

Diagnosis: A species of Gavelinella with a strong spiral ridge

along the inner margin of the chambers on the spiral side of the test.

|     | Diameter 1 | Diameter 2 | Thickness |
|-----|------------|------------|-----------|
| 119 | 0.57m.m.   | 0.48       | 0.24      |
| 120 | 0.53       | 0.45       | 0.20      |
| 121 | 0.53       | 0.46       | 0.25      |

Description: A low trochospiral species; test free, biconvex, spiral side less concave than umbilical side; test partially involute; periphery very sharply rounded; in spiral view test sub-circular; sutures broad, raised, curved; aperture a low interiomarginal slit extending from near the periphery to the umbilicus; apertural face weakly domed; chambers gradually increase in size with ten to eleven chambers in the last whorl; a strong spiral ridge extends along the inner margins of the chambers of the spiral side; test surface smooth.

Variation: The prominence of the spiral ridge increases during the S.dispar Zone until it is distinctive in the uppermost S.dispar Zone.

Remarks: This species was first recorded by Brotzen from the Cenomanian. It is easily distinguished from other Albian species of this genus by the prominent spiral ridge and the sharp periphery.

Both Price (1977b) and Carter & Hart (1977) regarded it as zonally significant during the Albian. Price recorded this species as first occurring in the H.varicosum Subzone while Carter & Hart recorded rare 'primitive' forms in their Zones 5-6 and common well developed forms in Zone 6a.

Stratigraphic conclusion: This species occurs abundantly in the topmost Albian of southern England. Distinctive forms first occur in the topmost Albian where it is regarded to be of moderate stratigraphic significance.

Gavelinella intermedia (Berthelin, 1880)

(pl.11,figs.1,2,4;pl.12,figs.1-4)

- 1880 Anomalina intermedia Berthelin:67,pl.4,figs.14a,b  
1898 Anomalina ammonoides Reuss;Chapman:3,pl.1,fig.4  
1942 Gavelinella intermedia (Berthelin);Brotzen:52,text fig.18  
1954 Gavelinella intermedia (Berthelin);Bartenstein:49,pl.1,figs.21-28  
1960 Gavelinella intermedia (Berthelin);Moullade:132,pl.12,figs.15-17  
1965 Gavelinella (Berthelina) intermedia (Berthelin);Malapris:138,pls.  
1,2  
1972 Gavelinella (Berthelina) intermedia (Berthelin);Gawor-Biedowa:120,  
pl.15,figs.7-9  
1977a Gavelinella intermedia (Berthelin);Price:516,pl.60,figs.7,8  
1977a Gavelinella intermedia var.A Price:516,pl.60,figs.9-11  
1977 Gavelinella intermedia (Berthelin);Carter & Hart:48,pl.1,figs.  
33-35

Diagnosis: A small species of Gavelinella with a weak umbilical boss, poorly inflated chambers, and weakly depressed sutures.

|     | Diameter 1 | Diameter 2 | Thickness |
|-----|------------|------------|-----------|
| 122 | 0.49m.m.   | 0.43       |           |
| 123 | 0.52       | 0.44       |           |
| 124 | 0.54       |            | 0.24      |
| 129 | 0.52       | 0.44       |           |
| 132 | 0.45       | 0.37       |           |
| 133 | 0.44       | 0.35       |           |
| 134 | 0.48       | 0.42       |           |
| 135 | 0.39       | 0.30       |           |

Description: A low trochospiral species; test free, partially involute; spiral side flattened, in spiral view test subcircular; periphery sharply rounded; sutures raised in early chambers, in latter



chambers sutures depressed; last chambers weakly inflated; apertural face weakly rounded or flat; in spiral view umbilical side concave, spiral side only weakly convex; aperture a low interio-marginal slit extending from near periphery to umbilicus; chambers gradually increase in size; test surface smooth; a smooth umbilical boss is present umbilically in some specimens.

Remarks: This species was originally described by Berthelin (1880) from the Gault Clay of Montcley. Both Malapris (1965) and Price (1977a) suggested that G.intermedia var.A. is only a variety of G.intermedia and not a separate species. This view is upheld in this study where the umbilical boss is very variable in size and specimens vary between end members either lacking an umbilical boss or with a large umbilical boss. These two forms have not been separated as any division would be completely arbitrary.

Price (1977b) regarded this as the most abundant benthonic Albian species which ranges throughout the Albian. He recorded G.intermedia var.A. ranging from the P.pusosianus Subzone to the Cenomanian. Both Price (1977a) and Carter & Hart (1977) postulated evolutionary lineages for this and the closely related species G.baltica and G.cenomanica. Both these authors thought that the latter two species evolved from G.intermedia although they did not agree when this occurred. These changes are very gradational and are thus very difficult to date precisely. Specimens of G.baltica which may be regarded as primitive forms are found throughout the M.inflatum Zone while distinctive forms are present in the S.dispar Zone. Specimens closely related to G.cenomanica are found throughout the S.dispar Zone but distinctive forms only occur in the topmost part of the S.dispar Zone.

Stratigraphic conclusion: This species occurs very abundantly in the Albian of southern and eastern England. It ranges throughout the Albian and appears to occur ubiquitously across northwest Europe

where it is of limited stratigraphic value.

Genus Lingulogavelinella Malapris, 1965

Type species: Lingulogavelinella albiensis Malapris, 1965

Lingulogavelinella albiensis Malapris, 1965

(pl.5, figs.13-15.)

1965 Lingulogavelinella albiensis Malapris:140, pl.4, figs.5-8

Diagnosis: A small, flattened, species of Lingulogavelinella with seven or eight chambers in the last whorl.

|     | Diameter 1 | Diameter 2 | Thickness |
|-----|------------|------------|-----------|
| 125 | 0.30m.m.   | 0.23       | 0.14      |
| 126 | 0.27       | 0.24       | 0.13      |

Description: Test free, trochospiral; spiral side flattened to weakly concave or convex; umbilical side convex; test involute with seven or eight chambers in the last whorl, sutures radial, curved, weakly depressed in last formed chambers; chambers increase gradually in size; periphery narrowly rounded, umbilicus depressed; in spiral view test subcircular; aperture an interiomarginal extra-umbilical/umbilical narrow slit, on spiral side relict slits are present giving a 'star shaped' appearance to the aperture; test surface smooth.

Remarks: This species was defined by Malapris (1965) from the Lower and Middle Albian of the Aube. Price (1975) suggested that the first appearance of this species is highly diachrous, first appearing in southern England in the Upper Albian, while in the Aube it occurs in both the Lower and Middle Albian.

Stratigraphic conclusion: A sporadically occurring species of little stratigraphic significance.

Lingulogavelinella jarzevae (Vasilenko, 1954)

(pl.11,figs.11,14.)

- 1954 Cibicides (Cibicides) jarzevae Vasilenko:121,pl.17,figs.3a-c
- ?1972 Lingulogavelinella formosa (Brotzen);Gawor-Biedowa:105,pl.14,figs.  
1a-c,text fig.7
- 1977 Lingulogavelinella jarzevae (Vasilenko);Carter & Hart:49,pl.1,  
figs.29,30

Diagnosis: A high sided species of Lingulogavelinella with a flattened spiral side.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 127 | 0.32m.m.   | 0.30       | 0.15   |
| 128 | 0.26       |            | 0.15   |

Description: Test free, trochospiral; spiral side flattened, umbilical side inflated, strongly convex; test involute; sutures radial, depressed; in umbilical view chambers increase rapidly in size, last chamber appears globular, early chambers of last whorl smooth, sutures not depressed; periphery rounded in spiral view, periphery normally rounded in section; in side views chambers on the umbilical side appear concave; aperture an interiomarginal extra-umbilical/umbilical narrow slit, on the spiral side relict slits are present giving a 'star shaped' appearance to the aperture; test surface smooth.

Remarks: This distinctive species is easily recognisable by its flat spiral side and strongly conical, elevated, umbilical side. Both Price (1977b) and Carter & Hart (1977) regarded this as a zonally significant species. Price recorded it from the C.auritus Subzone and S.dispar Zone while Carter & Hart recorded it occurring rarely in their Zones 5a-6, and commonly both in their topmost Albian Zone 6a and the Lower Cenomanian.

Stratigraphic conclusion: A rare species that occurs sporadically in the S.dispar Zone of southern England.

Superfamily ROBERTINACEA Reuss, 1850

Family CERATOBULIMINIDAE Cushman, 1927

Sub-family CERATOBULIMININAE Cushman, 1927

Genus Conorboides Hofker in Thalmann, 1952

Type species: Conorboides mitra Hofker, 1951

Conorboides lamplughi (Sherlock, 1914)

(pl.1,figs.12,13)

1914 Pulvinulina lamplughi Sherlock:290,pl.19,fig.16

1933 Discorbis turbo Eichenberg:20,pl.1,fig.11

1950 Lamarckina lamplughi (Sherlock);Ten Dam:49,text fig.5

1977 Conorboides lamplughi (Sherlock);Carter & Hart:50,pl.1,figs.21-23

Diagnosis: A subconical species of Conorboides with two chambers in the last whorl.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 130 | 0.29m.m.   | 0.27       | 0.17   |
| 131 | 0.25       | 0.24       | 0.21   |

Description: Test free, trochospiral; periphery rounded, few chambers to a whorl,two in the last whorl; sutures oblique on spiral side, radial, curved on umbilical side; umbilical side shows sutures weakly depressed, chambers weakly concave, spiral side conical; aperture a low interiomarginal umbilical arch: test surface smooth.

Remarks: This species was regarded as zonally significant by Price (1977b) who recorded it rarely in the Lower and lower Middle Albian. It only occurs in abundance in the O.raulinianus Subzone of the German Lower Albian. Carter and Hart (1977) recorded it rarely from their Zone 3 in southern England. It was recorded in the present study from the Lower Albian of Germany and the A.intermedius Subzone of southern England.

Stratigraphic conclusion: A rare, sporadically occurring species which has only been recorded from the Albian up to the level

of the A.intermedius Subzone.

Sub-family EPISTOMININAE Wedekind, 1937

The species of Epistomina and Hoeglundina are irregularly distributed in the Albian of northwest Europe. They occur most abundantly in the Middle Albian of southern England but appear less commonly in the lower Upper Albian. They show a gradual decline in abundance during the basal Upper Albian and last occur in the middle of the H.varicosum Subzone. Spatially, several of the species vary in their morphology and E.spinulifera, especially, shows a lateral variation changing from the typically coarsely ribbed specimens of southern England to smoother specimens in northern Germany. These genera are very rare in the Albian of the southern North Sea Basin. They appear to be very adaptable to environmental conditions, especially changes in depth/temperature and are very susceptible to diagenetic alteration. It is unlikely that mass transportation of specimens of these genera occurred during the Upper Albian as Price (1975) suggested, as the corroded nature of many of the Upper Albian specimens is probably due to diagenetic alteration.

Genus Epistomina Terquem, 1883

Type species: Epistomina regularis Terquem, 1883

Epistomina cretosa Ten Dam, 1947

(pl.13, figs.4,8,9.)

1947 Epistomina cretosa Ten Dam:29, fig.6

1948 Epistomina cretosa Ten Dam; Ten Dam:166

1950 Epistomina cretosa Ten Dam; Ten Dam:51, text fig.7a-c

1975 Epistomina cretosa Ten Dam; Magniez-Jannin:275, pl.16, fig.7

Diagnosis: A compressed species of Epistomina.

|     | Diameter 1 | Diameter 2 | Thickness |
|-----|------------|------------|-----------|
| 144 | 1.00m.m.   | 0.86       | 0.45      |
| 145 | 0.76       | 0.62       | 0.37      |
| 146 | 0.73       | 0.60       | 0.34      |

Description: Test free, compressed; chambers arranged in a low trochospire; sutural ribs very strong, boxed shaped with two keels; in spiral view test sub-ovate, irregular with a number of short spines extending in the plane of the trochospire; two apertures present, one a peripheral slit, the other oval and areal; in side view test weakly bi-convex; chambers gradually increasing in size; chamber surface smooth; greatest height at axis of trochospire.

Remarks: This species was originally described by Ten Dam (1947) from the Albian of Holland and Germany. It has also been described by Magniez-Jannin (1975) from the Middle Albian of the Aube and by Robaszynski et.al.(MS.) from the E.lautus Zone of Wissant. Price (1977) did not record this species.

Stratigraphic conclusion: A rare species which has only been recorded from the E.lautus Zone.

Epistomina spinulifera (Reuss, 1863)

(pl.13,figs.10-12.)

- 1863 Rotalia spinulifera Reuss:93,pl.13,figs.3a,b,4-5a-c
- 1898 Pulvinulina spinulifera Reuss;Chapman:9,pl.2,figs.1a-c
- 1933 Rotalia polypoides Eichenberg:21,pl.3,figs.1a-c
- 1947 Epistomina spinulifera (Reuss);Ten Dam:28,figs.7a-c
- 1948 Epistomina spinulifera (Reuss);Ten Dam:170,pl.2,fig.5
- 1972 Epistomina spinulifera polypoides (Eichenberg);Gawor-Biedowa:  
138,pl.18,figs.4a-c,5,6a,b
- 1975 Epistomina spinulifera (Reuss);Price:636,pl.2,figs.1,2
- 1975 Epistomina polypoides Eichenberg;Price:636,pl.2,figs.3,4

Diagnosis: A large, lenticular, species of Epistomina with strong ribs.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 147 | 1.11m.m.   | 0.89       | 0.62   |
| 148 | 0.78       | 0.56       | 0.52   |
| 149 | 1.15       | 0.97       |        |

Description: Test free, lenticular; chambers arranged in a low trochospire; test biconvex, margin sharp, bearing a number of short spines; sutural ribs strong, thickened, elevated; chambers gradually increase in size; in side view umbilical side is strongly convex, spiral side only weakly convex; two apertures present, one a peripheral slit, the other oval and areal; surface smooth; maximum height at axis of trochospire.

Variation: Both the size of specimens and the strength of the ribbing is very variable. The number of peripheral spines varies.

Remarks: This species was first recorded by Reuss (1863) from the Gault Clay of Folkestone. He described it as a variable species in both its reticulate pattern and the degree of ornamentation. Chapman (1898) noted that at Folkestone, from Bed i to Bed vii, specimens of this species gradually increase in size and numbers only to disappear fifty five feet from the top of the succession. He also noted that after its acme in Bed vii it decreased in numbers.

Eichenberg (1933) recorded this species from the Albian of Germany. He also erected a new species, E. polypioides, which he only vaguely defined and inadequately figured. Since he described it as a large, variable form with ribs, it is placed in the synonymy of this species. Ten Dam (1947), Magniez-Jannin (1975) and Carter & Hart (1977) also regarded these two species as synonymous. However, Price

(1975) did not and he showed these two species to be geographically mutually exclusive, the former only occurring in southern England and Holland. Owing to the variability of this species, both laterally and stratigraphically, the relationship between the different forms of this species is not simple. The variation in morphology is environmentally controlled and has been greatly influenced by both the depth and temperature. The smoother forms probably occur in colder, deeper water.

Many of the Upper Albian specimens are poorly preserved. This is not entirely due to reworking and is probably largely the result of the instability of their aragonitic test in carbonate rich sediment.

It has been regarded as stratigraphically important by Price (1977b) who recorded it from the H.spathi Subzone to the D.cristatum Subzone. Carter & Hart (1977) recorded it from their Zones 2 to 4a and rarely above. The last occurrence of this species coincides with a major change in the environment at the end of the H.orbigny Subzone and is therefore probably environmentally controlled.

Stratigraphic conclusion: An abundant species that occurs commonly in the Middle and lower Upper Albian. It was found rarely in the Lower Albian of Germany. This species is of major stratigraphic significance across much of northwest Europe, but has not been recorded in any abundance from the Southern North Sea Basin.

Epistomina sp.A.sp.nov.

(pl.13, figs.13-15.)

Diagnosis: A large, lenticular, smooth species of Epistomina.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 151 | 1.62m.m.   | 1.56       | 0.70   |
| 152 | 1.15       | 1.07       | 0.60   |
| 153 | 0.89       | 0.87       | 0.51   |



Description: Test free, large, lenticular; chambers arranged in a low trochospire, test biconvex; margins sharp, drawn out at irregular intervals into strong spines which occur in the plane of the trochospire; sutures very weakly raised or flush to the test surface; aperture a large peripheral slit, areal aperture not observed; chambers gradually increase in size; in side view umbilical side convex, spiral side weakly convex; apertural face obliquely inclined; test surface smooth; maximum height at axis of trochospire.

Remarks: This species differs from E. spinulifera by being more compressed, lacking the coarse ribbing, and apparently lacking an areal aperture. It was only recorded from the H. varicosum Subzone of southern England where it shows no sign of decalcification or of reworking. It appears to have evolved from E. spinulifera, but may prove only to represent a deeper (colder) water ecophenotype of this species.

Stratigraphic conclusion: This species was recorded abundantly from the H. varicosum Subzone of southern England where it is of local stratigraphic significance.

Genus Hoeglundina Brotzen, 1948

Type species: Rotalia elegans d'Orbigny, 1826

Hoeglundina carpenteri (Reuss, 1862)

(pl. 13, figs. 5-7.)

1862 Rotalia carpenteri Reuss; 94, pl. 13, figs. 6a-c

1898 Pulvinulina carpenteri (Reuss); Chapman: 8, pl. 1, figs. 11a-c

1948 Epistomina carpenteri (Reuss); Ten Dam: 165, pl. 1, fig. 4

1950 Epistomina carpenteri (Reuss); Ten Dam: 50, pl. 4, fig. 3

1954 Hoeglundina carpenteri (Reuss); Hofker: 194, text figs. 36, 37

1977 Hoeglundina carpenteri (Reuss); Carter & Hart: 50, pl. 1, figs. 15-17

Diagnosis: A species of Hoeglundina with a serrated keel.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 137 | 0.65m.m.   | 0.53       | 0.33   |
| 138 | 0.64       | 0.61       |        |
| 139 | 0.65       | 0.56       |        |

Description: A small lenticular species; test free; chambers arranged in a low trochospire; test biconvex, margin serrated; sutures thick, flush to test surface or weakly raised; in umbilical view test subcircular, a discontinuous serrated ridge is present slightly inset from the periphery; two apertures are present, one a peripheral slit, the other areal; in side view umbilical side convex, spiral side weakly convex; chambers gradually increasing in size, chamber surface smooth to finely granular; apertural face oblique; greatest height at axis of trochospire.

Remarks: This species was first described by Reuss (1863) who figured a specimen 0.5mm. in diameter. This specimen was collected from the Gault Clay of Folkestone. No specimens were recorded by him from the Gault Clay of Germany. Subsequently, Ten Dam (1948) recorded it from the Albian of Holland and Hofker (1954) placed it in the genus Hoeglundina Brotzen, 1948 based on the presence of internal partitions. Price (1975, 1977b) regarded it as zonally significant and recorded it ranging from the A.intermedius Subzone to the D.cristatum Subzone. He also recorded derived specimens from the H.orbigny and H.varicosum Subzones. Specimens from these latter Subzones recorded in the present study were interpreted as either ecophenotypic variants of this species or were regarded as diagenetically altered, they were not interpreted as derived. Carter & Hart (1977) also regarded this species as zonally significant and they recorded it from their Middle Albian Zones 3 and 4.

Stratigraphic conclusion: This species occurs rarely in the Lower Albian of Germany and commonly in the Middle and lower Upper

Albian of southern England. It last occurs at the base of the H. varicosum Subzone.

Hoeglundina chapmani (Ten Dam, 1948)

(pl.13, figs.1-3)

- 1898 Pulvinulina caracolla (Roemer); Chapman:7, pl.1, fig.9  
1898 Pulvinulina elegans (d'Orbigny); Chapman:6, pl.1, fig.8  
1933 Epistomina elegans (d'Orbigny); Eichenberg:22, pl.7, fig.1  
1948 Epistomina chapmani Ten Dam:166, pl.1, figs.5a-c  
1950 Epistomina chapmani Ten Dam; Ten Dam: 53, pl.4, fig.6  
1954 Hiltermannia chapmani (Ten Dam); Hofker:191, text figs.27-32  
1975 Epistomina chapmani Ten Dam; Magniez-Jannin:274, pl.16, figs.1-3  
1977 Hoeglundina chapmani Ten Dam; Carter & Hart:51, pl.1, figs.18-20

Diagnosis: A species of Hoeglundina with a smooth periphery.

|     | Diameter 1 | Diameter 2 | Height |
|-----|------------|------------|--------|
| 140 | 0.54m.m.   | 0.47       | 0.33   |
| 141 | 0.56       | 0.52       | 0.32   |
| 142 | 0.52       |            | 0.26   |

Description: Test free, small, lenticular, chambers arranged in a low trochospire; test biconvex, margins sharp; sutures thick, flush to test surface; two apertures are present, one a peripheral slit, the other oval and areal; in spiral view periphery subcircular, smooth to weakly serrated; in side view test biconvex, umbilical side convex, spiral side weakly convex; chambers gradually increasing in size, chamber surface smooth; greatest height at axis of trochospire.

Remarks: This species had a very confused taxonomic history until Ten Dam (1950) recognised it as a distinct species. It was first recorded by Chapman (1898) from Beds i to ix at Folkestone. Ten Dam recorded it from the Lower Albian of Holland. Eichenberg

(1933) recorded it from the Middle Albian of Germany and Magniez-Jannin (1975) recorded it as sporadic in the Middle Albian of the Aube. Price (1977b) regarded this species as zonally significant and recorded it rarely from the Lower Albian clays of Germany and commonly from the L.lyelli to H.orbignyi Subzones. He regarded specimens from the H.varicosum Subzone as derived. In this study these specimens are regarded as ecophenotypes which may have been altered during diagenesis. Carter & Hart (1977) regarded this species as zonally significant ranging through their Middle Albian Zones 3-4a.

Stratigraphic conclusion: This species occurs rarely in the Lower Albian of Germany and commonly in the Middle Albian of southern England. It occurs less commonly in the lowest Upper Albian and last occurs at the base of the H.varicosum Subzone.

## CHAPTER 5

### TAXONOMY: OSTRACODA

#### Taxonomic Introduction

The classification used is that described by Van Morkhoven (1962). Reference was also made to the Treatise of Invertebrate Palaeontology, Part Q, Arthropoda 3, Moore & Pitrat (1961). The classification described in the former work has been utilised to minimise both taxonomic and biostratigraphic confusion. Several other major taxonomic works have thus been ignored and emphasis has been placed at the specific level in an attempt to maintain taxonomic cohesion and biostratigraphic relevance.

A full synonymy, a diagnosis and a brief description has been included for each species. The intra-specific variation exhibited by the commoner species has been described in a separate section. Typical specimens of each species have been photographed and these figured specimens have been designated specimen numbers. The measurements (m.m.) of each of these specimens have been included after the diagnosis. The remarks section includes the problems of taxonomy and synonymy and the previously recorded distribution and stratigraphic range of each species. The stratigraphic details have briefly been summarised in the stratigraphic conclusion and these have been related to the macrofaunal zonation. The details of range, abundance and biostratigraphic significance of each species are included in Chapter 8.

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIDA Müller, 1894

Suborder CLADOCOPINA Sars, 1866

Family POLYCOPIDAE Sars, 1866

Genus Polycope Sars, 1866

Type species: Polycope orbicularis Sars, 1866

Polycope nuda Kaye, 1965

(pl.14, fig.3)

1965c Polycope nuda Kaye:221, pl.4, figs.1-3

Diagnosis: A large, moderately inflated, species of Polycope with a subcircular outline and smooth valve surface.

| Specimen<br>Number | Length   | Height | Width |
|--------------------|----------|--------|-------|
| 158 L.V. Female    | 0.41m.m. | 0.34   | 0.1   |
| 158 R.V. Female    | 0.41     | 0.34   | 0.12  |

Description: Valves large, moderately inflated with a sub-circular outline; lateral surface mainly smooth, but with some weak irregular reticulation, particularly antero-ventrally.

Remarks: Kaye (1965c) first described this species from the D.niobe Subzone of Wrotham, Kent. Kaye remarked that this species was found consistently, but never commonly, throughout the Gault Clay making its first appearance in the D.niobe Subzone and occurring most commonly in that Subzone. Weaver ( MS., 1978 ) recorded this species as occurring rarely throughout the Cenomanian of southern England. He noted that the Cenomanian specimens of this species are similar to the type material but are considerably smaller.

The occurrence of this species in the Albian represents the first for this genus.

Stratigraphic conclusion: This species occurs very sporadically in the Middle and Upper Albian of southern England. It first occurs

in the D.niobe Subzone and ranges through into the Cenomanian and is of limited stratigraphic value.

Polycope oweni Kaye, 1965

(pl.14,fig.1.)

1965c Polycope oweni Kaye:222,pl.4,figs.11-15

Diagnosis: A small, subcircular species of Polycope with a strongly reticulated surface.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 159 L.V. Female | 0.41m.m. | 0.33   | 0.09  |
| 159 R.V. Female | 0.41     | 0.33   | 0.09  |

Description: Valves small and weakly inflated with a sub-circular outline. The lateral surfaces are strongly but variably reticulated, often with numerous small spines at the junctions of the reticulation. This reticulation covers the whole of the lateral surface.

Remarks: This species was first recorded by Kaye (1965c) from the H.orbignyi Subzone of Wrotham, Kent. He remarked that this species never occurs abundantly in the Gault Clay and that it was only recorded from clays of post A.intermedius subzonal age. Weaver ( MS., 1978 ) recorded this species as rare throughout the Cenomanian of southern England.

This species differs from P.nuda by the presence of strong reticulation and its smaller size.

Stratigraphic conclusion: This species was first recorded from the D.niobe Subzone. It is rare in the Middle and Upper Albian and Cenomanian of southern England and is of limited stratigraphic value.

Suborder PLATYCOPINA Sars, 1866

Family CYTHERELLIDAE Sars, 1866

Genus Cytherella Jones, 1849

Type species: Cytherina ovata Roemer, 1840

Cytherella ex.gr.C.ovata (Roemer, 1840)

(pl.14,figs.4,5,9.)

1840 Cytherina ovata Roemer:104,pl.16,fig.21

1845 Cytherina ovata Reomer;Reuss:16,pl.5,fig.35

1849 Cythere(Cytherella)ovata (Roemer);Jones:28,pl.7,figs.24b-g

non1854 Cytherella ovata (Roemer);Bosquet:45,pl.8,figs.1a-f

1890 Cytherella ovata (Roemer);Jones & Hinde:44,pl.3,figs.48-49,51-54;

non fig.50(C.truncata Bosquet)

1890 Cytherella obovata Jones & Hinde:46,pl.3,figs.46,47

1898 Cytherella ovata (Roemer);Chapman:343

1940 Cytherella ovata (Roemer);Bonnema:93,pl.1,figs.1-16

1956 Cytherella ovata (Roemer);Deroo:1508,pl.1,figs.4-6

1958 Cytherella ovata (Roemer);Howe & Laurencich:251

1958 Cytherella ovata (Roemer);Oertli:1502,pl.1,figs.10-29

1966 Cytherella ovata (Roemer);Gründel:12,pl.1,fig.2

1971b Cytherella ovata (Roemer);Damotte:55,pl.1,figs.2-7

1977 Cytherella gr.ovata (Roemer);Charollais et.al:pl.1,fig.1

1978 Cytherella ovata (Roemer);Van der Wiel:pl.1,figs. 2,3

?1978 Cytherella ovata (Roemer);Neale:pl.1,figs.1,2

Diagnosis: An ovate species of Cytherella with a straight to slightly convex ventral margin. Dorsal margin convex, greatest height at mid-length, greatest breadth at three fifths length.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 160 L.V. Female | 0.87m.m. | 0.48   | 0.23  |
| 161 L.V. Male   | 0.81     | 0.41   | 0.18  |
| 162 R.V. Male   | 0.92     | 0.52   | 0.27  |



**Description:** A heavily calcified species which is ovate in outline, has a broadly rounded anterior margin, and a more narrowly rounded posterior margin; ventral margin varies between slightly convex in females to straight, or slightly convex, in males. The greatest height of the carapace occurs at mid-length. Males differ by being shorter, less high, and less wide than females.

**Remarks:** This is one of the most common and most documented of Cretaceous species. It has been recorded from much of the European Cretaceous but has been very confused because the type material of Roemer has been lost. Demotte (1971b) however, has figured two topotypes from the Upper Campanian of Germany. Because of the confused taxonomy, the apparently long stratigraphic range, and the difficulty in separating it from other species of Cytherella, this species has been recorded as ex.gr.

Although this species is relatively consistent in outline and size during the Albian further differentiation of this group is difficult without a detailed study, and that is not within the scope of this thesis. However, Weaver (MS.) documented the variation of this species during the Cenomanian and reviewed this species very thoroughly.

**Stratigraphic conclusion:** A common, long ranging species that is of limited stratigraphic value.

Cytherella gründeli Weaver (MS.)

(pl.14, figs.14,17.)

1966 Cytherella sp. Gründel:83, pl.1, figs.6,7

**Diagnosis:** A small species of Cytherella with straight,

parallel, dorsal and ventral margins, and a wedge shaped outline in dorsal view.

|               | Length   | Height | Width |
|---------------|----------|--------|-------|
| 164 Female C. | 0.68m.m. | 0.40   | 0.15  |

Description: The dorsal and ventral margins are straight and parallel in the right valve but weakly converge towards the anterior in the left valve. The anterior and posterior margins are broadly rounded. A flattened rim is present around the anterior margin. The carapace is wedge shaped in dorsal view. The lateral surface is smooth.

Remarks: This species was first figured by Gründel (1966) from the Planus Zone of Saxony. It was recognised as a separate species by Weaver (MS.) who recorded it commonly in the Cenomanian of southern England. This species is very difficult to separate from juveniles of the larger species of Cytherella. In the Albian it was recorded rarely in the S.dispar Zone.

Stratigraphic conclusion: In the Albian this species occurs rarely in the S.dispar Zone and is of limited stratigraphic value. It is common in the Cenomanian.

Cytherella sp.cf.C.truncata (Bosquet, 1847)

(pl.14, figs.7,8,10,11,12,13.)

1847 Cythere truncata Bosquet: 357, pl.1, figs.2a-c

1971 Cytherella cf.ovata (Roemer); Keen & Siddiqui: 62, pl.1, figs.1,9

Diagnosis: An elongate-ovate species of Cytherella with the ventral half of the posterior margin in the right valve truncated. Left valve sub-rectangular.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 165 L.V. Female | 0.86m.m. | 0.46   |       |
| 166 L.V. Female | 0.75     | 0.41   |       |

|                 |      |      |      |
|-----------------|------|------|------|
| 167 R.V. Male   | 0.79 | 0.51 | 0.17 |
| 168 R.V. Female | 0.83 | 0.46 |      |
| 169 L.V. Male   | 0.80 | 0.43 | 0.17 |

Remarks: This species is similar to C.ovata but differs in being more elongate and possessing a truncated postero-ventral margin. Weaver (MS.) discussed this species in great detail and showed that it can be separated from C.ovata at least to the A-4 stage. Albian specimens of this species are very similar to those figured by Weaver from the Cenomanian of southern England and are, therefore, also tentatively assigned to the specimens from the Bosquet collection (Maastrichtian) which are deposited in the British Museum.

This species is also similar to C.parallela (Reuss, 1846) from which it differs in having a convex dorsal margin.

Stratigraphic conclusion: This species occurs commonly in the Middle and Upper Albian of England. It also occurs commonly in the Cenomanian of the British Isles. It is a long ranging species of limited stratigraphic value.

Cytherella speetonensis Kaye, 1963

(pl.14,figs.2,6.)

1963b Cytherella speetonensis Kaye:112,pl.18,figs.7,8

?1977 Cytherella gr.parallela (Reuss);Charollais et.al:pl.1,fig.2

1978 Cytherella speetonensis Kaye;Neale:pl.1,fig.5

Diagnosis: An elongate species of Cytherella with concave, sub-parallel, dorsal and ventral margins. The carapace is fragile.

|                 | Length   | Height |
|-----------------|----------|--------|
| 170 R.V. Female | 0.73m.m. | 0.38   |
| 171 R.V. Female | 0.77     | 0.42   |

Description: This elongate species has concave, sub-parallel,

dorsal and ventral margins. Both the anterior and posterior margins are semicircular although both may be bluntly rounded; greatest width at five sixths length. The valve surfaces are smooth.

Variation: The size of the adult specimens and the degree of indentation of both the dorsal and ventral margins is variable.

Remarks: This species was originally described by Kaye (1963b) from the Middle and Upper Barremian of Speeton, Yorkshire. Neale (1972, 1978) records it ranging from the Upper Hauterivian to the Barremian. It has not been recorded previously from the Aptian or the Albian. Charollais et.al. (1977) described a similar form from the Middle and Upper Albian of Switzerland but included it in C.gr. parallela (Reuss).

This species can easily be distinguished from other species of this genus by the presence of concave dorsal and ventral margins.

Stratigraphic conclusion: A long ranging species, with a confused taxonomic history, which occurs sporadically in the Middle and Upper Albian of England. It is of limited stratigraphic value.

#### Genus Cytherelloidea Alexander, 1929

Type species: Cythere(Cytherella)williamsoniana Jones, 1849

The original figured specimens of C.williamsoniana include several species including C.chapmani (Jones & Hinde, 1890) and C.granulosa.

Cytherelloidea chapmani (Jones & Hinde, 1890)

(pl.15,figs.3,5,6,8,10,11)

1890 Cytherella chapmani Jones & Hinde:49,pl.3,fig.70

1893 Cytherella chapmani Jones & Hinde;Chapman & Sherborn:346

?1898 Cytherella chapmani Jones & Hinde;Chapman:345

?1956 Cytherelloidea chapmani (Jones & Hinde);Deroo:1509

1956 Cytherelloidea circumvallata Bonnema;Mertens:181,pl.8,figs.4-6

1962 Cytherelloidea circumvallata Bonnema;Ellermann:397,pl.1,fig.4

1963b Cytherelloidea parawilliamsoniana Kaye:115,pl.20,figs.20-23

1964c Cytherelloidea chapmani (Jones & Hinde);Kaye:70,pl.9,figs.

15-19,22

1964c Cytherelloidea parawilliamsoniana Kaye:73,pl.9,fig.23

1966 Cytherelloidea circumvallata Bonnema;Gründel:12,pl.1,fig.19

1971b Cytherelloidea chapmani (Jones & Hinde);Damotte:57,pl.1,fig.12

?1977 Cytherelloidea chapmani (Jones & Hinde);Charollais et.al:pl.1,  
fig.3

1978 Cytherelloidea chapmani (Jones & Hinde);Van der Wiel:pl.1 fig.4

Diagnosis: A species of Cytherelloidea with a prominent median rib which is connected to the anterior end of the dorsal rib.

|                    | Length   | Height | Width |
|--------------------|----------|--------|-------|
| 178 R.V. Female    | 0.62m.m. | 0.35   |       |
| 179 Dorsal, Female | 0.63     |        |       |
| 180 L.V. Male      | 0.64     | 0.33   | 0.15  |
| 181 L.V. Female    | 0.59     | 0.33   | 0.13  |
| 183 R.V. Female    | 0.58     | 0.35   | 0.12  |
| 184 L.V. Male      | 0.62     | 0.32   | 0.11  |

Description: Carapace sub-rectangular in lateral view, the lateral surface is covered by a series of inflated ribs. The anterior marginal rib is pronounced and is continued along the ventral margin as a low shelf. The posterior rib is inflated and extends along the ventral two thirds of the posterior margin, at either end of this rib distinct nodes are present. The ventral longitudinal rib is pronounced and slightly arcuate, it is not connected to the postero-ventral node. A short rib, approximately one third the length of the carapace, is connected to the postero-dorsal node. The dorsal rib is short and is connected to the anterior end of the median rib. The median rib is prominent and ventrally convex, it is not joined posteriorly to either of the posterior nodes. The intercostal areas are smooth.

Males are less inflated, longer and less high with less prominent ribs than females.

Variation: The main variation occurs in the prominence and position of the ribs. The posterior rib becomes more inflated and the nodes become wider apart in the Upper Albian, while the median and dorsal ribs become less pronounced, and the anterior rib moves to the anterior valve margin.

Remarks: The original material of this species has been lost. Kaye (1964c) therefore, selected the Chapman specimen, that was mentioned by Jones (1890), as lectotype. This species has been called C. chapmani in the Anglo-Paris Basin but has previously been called C. circumvallata Mertens, 1956 in Germany.

This species was confused by Kaye (1963b) who erected the new, closely related species C. knaptonensis Kaye, 1963b from the Middle Albian of Yorkshire and C. parawilliamsoniana Kaye, 1963b from the 'chalk detritus', Charing, Kent. The latter species was regarded by Kaye as synonymous with fig. e of Jones (1849, pl. 7) which had been collected from the 'chalk detritus' of Charing, Kent. However, Kaye erected the holotype for this species from the Middle Albian of Speeton. Weaver (MS.) did not record this species from the Cenomanian of southern England and Gründel (1966) regarded it as synonymous with C. circumvallata. C. knaptonensis is retained as a separate species although it is closely related to both C. chapmani and C. kayei Weaver (MS.).

C. circumvallata has been recorded by Mertens (1956), Ellerman (1962), and Gründel (1966) from the Albian of Germany. Gründel (1966) recorded it from the Upper Albian and Lower Cenomanian and regarded it as a chronospecies of C. chapmani which he thought typical of the Lower and Middle Albian. Mertens regarded C. circumvallata as typical of the Middle Albian. The figured specimens of the above

authors are all regarded as synonymous with C. chapmani.

Weaver (MS.) has described a new, closely related species, C. kayei, from the Cenomanian of southern England. This species is regarded as a chronospecies of C. chapmani which evolved from the latter in the C. auritus Subzone. This species is the result of the gradual adaption of C. chapmani to changing environmental conditions during the Upper Albian and especially during the late H. varicosum Subzone.

Stratigraphic conclusion: This species was recorded from the Middle and Upper Albian of the Anglo-Paris Basin. It has also been recorded from the Lower Albian of Germany. A common species that occurs ubiquitously across northwest Europe and is of moderate stratigraphic significance.

Cytherelloidea globosa Kaye, 1964

(pl. 14, figs. 15, 18.)

1964c Cytherelloidea globosa Kaye: 71, pl. 9, figs. 7, 9, 10

Diagnosis: An inflated species of Cytherelloidea with a prominent median sulcus which is separated laterally from the ventral margin by a longitudinal swelling.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 172 L.V. Female | 0.53m.m. | 0.30   |       |
| 173 R.V. Female | 0.53     | 0.32   | 0.17  |

Description: The carapace is sub-rectangular, inflated, with semicircular anterior and posterior margins. The lateral surface can be divided into four sections which are separated by the deep, prominent, median sulcus. The posterior rib is very inflated and the postero-dorsal and postero-ventral nodes have merged. The anterior lateral area is strongly and evenly inflated while the ventral area consists of an inflated longitudinal rib. From the deep median

sulcus to the dorsal margin a broad marginal shelf is present. Two linear depressions run obliquely from the median sulcus to the antero-ventral and postero-ventral margins, these separate the inflated areas of the lateral surface. The lateral surface is smooth.

Remarks: This species was first described by Kaye (1964c) from the Cambridge Greensand (Cenomanian). Weaver (MS.) has also recorded it from the Glauconitic Marl of Culver Cliff (Isle of Wight). In the present study it was only recorded from the Red Chalk of Hunstanton.

Stratigraphic conclusion: A rare species which has only been recorded from the Upper Albian and lowest Cenomanian. It is of limited stratigraphic value.

Cytherelloidea kayei Weaver (MS.)

(pl.14, fig.16.)

Diagnosis: A species of Cytherelloidea with a strong anterior marginal rib, a short arcuate ventral rib and very reduced dorsal and ventral ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 469 R.V. Female | 0.63m.m. | 0.37   | 0.13  |

Description: A subrectangular species with semicircular anterior and posterior margins. A very strong anterior rib continues along the ventral margin as a narrow shelf. The ventral rib is well developed extending approximately half the length of the carapace, it is slightly concave dorsally, and is not connected to the ventral rib.

Remarks: This species was described by Weaver (MS.) from the Cenomanian of southern England where he recorded it occurring throughout the Cenomanian. He noted that this species is similar to C.knaptonensis which Kaye (1963b) described from the Upper Albian of Speeton. It is also similar to C.chapmani, but differs in being more inflated in dorsal view, and having more reduced middle and dorsal



ribs. This species first occurs in the S.dispar Zone where it has clearly evolved from M.inflatum Zone specimens of C.chapmani. This evolutionary sequence is directly related to the gradual change in the environment during the Upper Albian.

Stratigraphic conclusion: A rare species that occurs in the S.dispar Zone. These specimens are primitive forms of this typically Cenomanian species. It is of moderate stratigraphic significance.

Cytherelloidea knaptonensis Kaye, 1963

(pl.15,fig.7.)

1963b Cytherelloidea knaptonensis Kaye:114,pl.19,figs.10-12

1964c Cytherelloidea knaptonensis Kaye;Kaye:pl.9,figs.20,21

1978 Cytherelloidea knaptonensis Kaye;Neale:pl.1,fig.7

Diagnosis: A species of Cytherelloidea with two, large, posterior nodes and poorly developed dorsal and median ribs.

|     |           | Length   | Height | Width |
|-----|-----------|----------|--------|-------|
| 174 | L.V. male | 0.60m.m. | 0.32   | 0.14  |

Description: The carapace is subrectangular with semicircular anterior and posterior margins. The two, inflated, posterior nodes are connected by a short rib. From the postero-dorsal node a rib extends two-fifths the length of the carapace. The postero-ventral node is in line with, but separated from, a prominent arcuate ventral rib which extends half the length of the carapace. The anterior rib is distinct and continues ventrally as a marginal shelf. The median rib is narrow, poorly developed, and curves around the ventral margin of the large muscle pit. The lateral surface is smooth.

Remarks: This species was first described by Kaye (1963b) from

the Middle Albian of Yorkshire. Kaye (1964c) also recorded this species from the Gault Clay at Burwell and Leighton Buzzard. He noted that this species is closely related to C.parawilliamsoniana Kaye, 1963b and C.chapmani. Neale (1978) refigured the holotype and recorded it from the H.dentatus Zone to the S.dispar Zone. Weaver (MS.) did not record this species from the Cenomanian of southern England.

Gründel (1966) regarded this species as synonymous with C.circumvallata Bonnema. This statement is contradictory since the differences between C.circumvallata and C.knaptonensis are greater than the differences between C.circumvallata and C.chapmani. The latter two species are here regarded as synonymous. The scarcity of specimens of C.knaptonensis has not facilitated a phylogenetic study and this species may yet, with further research, prove to be an ecophenotypic variant of C.chapmani.

Stratigraphic conclusion: A rare species that was only recorded from the Red Chalk of Yorkshire. It ranges from the A.intermedius Subzone to the S.dispar Zone and is geographically very limited in distribution. It is of limited stratigraphic value.

Cytherelloidea stricta (Jones & Hinde, 1890)

(pl.15, figs.1,2,4)

?1847 Cytherina serrata Williamson:79, pl.4, fig.79

1849 Cytherella williamsoniana Jones:31, pl.7, figs.26a-d,g,h. (non figs. 26e,f.)

1890 Cytherella williamsoniana Jones; Jones & Hinde:48, pl.3, figs. 57-62

1890 Cytherella williamsoniana stricta Jones & Hinde:48, pl.3, fig.71

1893 Cytherella williamsoniana stricta Jones & Hinde; Chapman & Sherborn; 346

- 1898 Cytherella williamsoniana stricta Jones & Hinde; Chapman:344
- non1929 Cytherelloidea williamsoniana stricta (Jones & Hinde);  
Alexander: 56, pl.2, fig.10
- 1956 Cytherelloidea dalumensis Mertens;180,pl.8,figs.1-3
- 1956 Cytherelloidea stricta (Jones & Hinde);Deroo:1509,pl.1,figs.  
7-8
- 1958 Cytherelloidea stricta (Jones & Hinde);Howe & Laurencich:270
- 1963b Cytherelloidea stricta (Jones & Hinde);Kaye:117,pl.19,figs.  
14,15
- 1964c Cytherelloidea stricta (Jones & Hinde);Kaye:74,pl.9,figs.1-3,  
5,6
- ?1965 Cytherelloidea stricta (Jones & Hinde);Baynova:289
- 1966 Cytherelloidea stricta (Jones & Hinde);Gründel:15,pl.1,fig.20
- 1971b Cytherelloidea stricta (Jones & Hinde);Damotte:57,pl.1,fig.12
- 1978 Cytherelloidea stricta (Jones & Hinde);Van der Wiel:pl.1,fig.5
- 1978 Cytherelloidea stricta (Jones & Hinde);Neale:pl.1,fig.6

Diagnosis: A species of Cytherelloidea with prominent marginal ribs and posterior marginal denticulation.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 175 L.V. Female | 0.71m.m. | 0.38   | 0.14  |
| 176 R.V. Female | 0.71     | 0.43   | 0.17  |
| 177 L.V. Male   | 0.69     | 0.42   | 0.17  |

Description: A subrectangular species with prominent marginal ribs. The anterior rib is semicircular and extends ventrally as a narrow marginal shelf. The posterior rib has a poorly inflated node at the postero-dorsal end which is connected to the dorsal rib. This rib extends two thirds the length of the carapace. In the mid region of the valve a slight swelling exists. Between this swelling and the anterior end of the dorsal rib a small, deep, muscle

pit is present. The ventral rib is concave dorsally and extends half the length of the carapace and is not connected to the posterior rib. Marginal denticulation is present both anteriorly and posteriorly in the -1 juveniles of this species. The adult has eight denticles posteriorly. The anterior denticles are poorly developed.

Remarks: This distinctive species has a confused taxonomic history which has been thoroughly documented by Kaye (1964c). It has been described from the Upper Albian of Germany by Mertens (1956), and Gründel (1966) and from the Upper Albian of France by Deroo, (1956) and Damotte (1971b). Hart (1973) recorded it first appearing at the base of the D.cristatum Subzone at Copt Point. Kaye did not specify the horizon at Folkestone from which he collected his samples. Van der Wiel (1978) recorded this species occurring 2.4m below the cristatum nodule bed of Wissant indicating that this species first appears in the A.daviesi Subzone. In the present study this species has always been recorded first appearing in either the D.cristatum or A.daviesi Subzone. It occurs commonly throughout the Upper Albian and ranges into the Cenomanian. Weaver (MS.) recorded it less commonly in the Upper Cenomanian than the Lower Cenomanian. Baynova (1965) recorded this species in the Lower and Middle Albian of Bulgaria, but did not figure it. However, it is very distinctive and not easily confused with any of the Albian species recorded in this study and it may, therefore, be concluded that this species occurs earlier in eastern Europe, migrating into the Anglo-Paris and southern North Sea Basins ubiquitously during the A.daviesi and D.cristatum subzones.

Stratigraphic conclusion: A common species that first appears in the A.daviesi Subzone and ranges into Cenomanian. It is a major zonal indicator.

Suborder PODOCOPINA Sars, 1866

Family BAIRDIIDAE Sars, 1888

Genus Bairdia McCoy, 1844

Type species: Bairdia curtus McCoy, 1844

Baridia pseudoseptentrionalis (Mertens, 1956)

(pl.15, figs.12,13)

- 1840 Cytherina subdeltoidea Münster; Roemer:105, pl.15, fig.22
- 1849 Bairdia subdeltoidea (Münster); Jones:23, pl.5, figs.15a-f
- 1890 Bairdia subdeltoidea (Münster); Jones & Hinde:5, pl.2, figs.31-34
- 1956 Bairdoppilata pseudoseptentrionalis Mertens:182, pl.8, figs.  
7-10; pl.13, figs.89,90
- 1956 Bairdoppilata roemeri Deroo:1509, pl.1, figs.9-12
- 1958 Bairdoppilata? roemeri Deroo; Howe & Laurencich:82
- 1965c Bairdia pseudoseptentrionalis (Mertens); Kaye:223, pl.2, figs.1,3-6
- 1966 Bairdia pseudoseptentrionalis (Mertens); Gründel:15, pl.1, fig.18
- 1971b Bairdia pseudoseptentrionalis (Mertens); Damotte:58, pl.1, fig.15
- 1971 Bairdia pseudoseptentrionalis (Mertens); Keen & Siddiqui:63, pl.1,  
fig.2
- 1978 Bairdia pseudoseptentrionalis (Mertens); Van der Wiel:pl.1, fig.6

Diagnosis: A smooth, inflated, subtrapezoidal, species of  
Bairdia with gently curved margins.

|                  | Length   | Height | Width |
|------------------|----------|--------|-------|
| 178a L.V. Female | 1.21m.m. | 0.85   | 0.48  |
| 179a R.V. Female | 1.16     | 0.66   | 0.31  |

Description: The valves are strongly calcified and are very unequal in shape and size. The dorsal margin forms a high symmetrical arch which terminates postero-ventrally at a short caudal process which is curved in outline. The antero-ventral margin is curved and merges with the antero-dorsal and lateral margins.

The lateral margin is gently curved and is symmetrical. The right valve is smaller and has a more pronounced caudal process, an indented ventral margin, bluntly pointed anterior margin, and symmetrically, dorsally truncated, dorsal margin. The greatest height and width occur at one half length. There is no apparent sexual dimorphism.

Remarks: This species has been recorded from across north-western Europe but has a confused stratigraphic history. Mertens (1956) originally described this species from the Albian of north-western Germany and recorded it ranging through the Upper Albian and Cenomanian while Deroo (1956) recorded it from the middle Vraconian to the Cenomanian of the Paris Basin. However, Kaye (1965c) stated that B.pseudoseptentrionalis occurs rarely in the Lower Gault but is more abundant in the Upper Gault. Unfortunately he gives no further stratigraphic or locality details, however, Neale (1973) based on the work of Kaye, recorded it from the Middle and Upper Albian. Gründel (1966) also gave a range for this species of Middle and Upper Albian. Unfortunately he gives no further details and does not include this species on his range charts. Van der Wiel (1978) recorded it first from the H.orbigny Subzone of Wissant and Weaver (MS.) recorded it ranging throughout the Cenomanian of southern England. Damotte recorded it first appearing in the M.inflatum Subzone of the Aube and ranging through the Cenomanian. In the present study this species was not recorded in abundance until the S.dispar Zone. Very few sporadically occurring specimens were recorded from the higher parts of the M.inflatum Zone and no specimens were recorded from the Middle Albian.

Stratigraphic conclusion: This species first occurs in abundance at the base of the S.dispar Zone. It is very rare in the lower Upper Albian but occurs commonly in the Cenomanian. This species is of zonal significance.

Family CYPRIDIDAE Baird, 1845

Subfamily PONTOCYPRIDINAE Van Morkhoven, 1962

Genus Argilloecia Sars, 1866

Type species: Argilloecia cylindrica Sars, 1866

Argilloecia valvula Kaye, 1965

(pl.16, fig.4)

1965c Argilloecia valvula Kaye:255, pl.7, figs.20-25

Diagnosis: A small species of Argilloecia with a strongly arched dorsal margin and a sharply pointed posterior margin.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 471aR.V. Female | 0.43m.m. | 0.17   | 0.11  |

Description: The carapace is small, elongate, and weakly calcified. The dorsal margin is strongly arched with no cardinal angles, the ventral margin is gently concave, the anterior margin is sharply rounded, and the posterior margin is bluntly pointed. The greatest length occurs near the ventral margin, the greatest height at one third to half length, and the greatest width at one half length. The valve surface is smooth and slopes gradually from the maximum width to all of the margins.

The muscle scar consists of a rosette of five scars.

Remarks: This species was described by Kaye (1965c) from the H.orbigny Subzone of Wrotham, Kent. He recorded it rarely in the Upper Gault and also noted that his record was the first of this genus in the Lower Cretaceous.

Stratigraphic conclusion: A rare species of limited stratigraphic significance.

Subfamily PARACYPRIDINAE Van Morkhoven, 1962

Genus Paracypris Sars, 1866

Type species: Paracypris polita Sars, 1866

Paracypris wrothamensis Kaye, 1965

(pl.16, figs 3,6,7)

**Diagnosis:** A large species of Paracypris with a sharply pointed posterior end and a very slightly convex dorsal margin with two strong cardinal angles.

|                   | Length   | Height | Width |
|-------------------|----------|--------|-------|
| 470 L.V. Female   | 0.87m.m. | 0.34   | 0.14  |
| 180a R.V. Female  | 0.89     | 0.34   | 0.12  |
| 180b L.V. -1 juv. | 0.73     | 0.29   | 0.12  |

**Description:** This elongate, compressed, species has greatest height at one quarter length and greatest width at mid-length. The dorsal margin is very gently convex with strong cardinal angles at either end; antero-dorsal margin straight, anterior margin curved from its dorsal extremity around the ventro-dorsal margin to the ventral margin; ventral margin long and concave. From the antero-dorsal cardinal angle a straight antero-dorsal margin extends to the sharply pointed posterior margin. The lateral surface is smooth and slopes gently from the greatest width to all the margins.

**Remarks:** This species was first described by Kaye (1965c) from the H.orbignyi Subzone of Wrotham, Kent. His holotype and paratypes were collected from this horizon and locality. He recorded it throughout the Gault Clay of southern England, first appearing in the A.intermedius Subzone, occurring rarely in the Lower Gault, but becoming more abundant in the Upper Gault. He regarded this change in abundance as a useful indicator of Upper Gault age. Unfortunately this species has not been recorded from the continent. However, Weaver (MS.) did record P.cf.P.wrothamensis as infrequent in the Lower Cenomanian but becoming quite common in the Middle and Upper Cenomanian of southern England. He noted that these specimens showed some variation in shape when compared to P.wrothamensis, all of them being somewhat similar to



P. wrothamensis.

Stratigraphic conclusion: This species occurs very rarely in the Middle Albian but becomes abundant in the D. cristatum Subzone. It is an important zonal indicator for the base of the Upper Albian in southern England.

Genus Pontocyprrella Lyubimova, 1955

Type Species: Bairdia harrisiana Jones, 1849

The genus Pontocyprrella Lyubimova, 1955 was regarded as synonymous with the genus Argilloecia Sars, 1866 by Van Morkhoven (1962). It is here retained as a separate genus. In contrast with Argilloecia the left valve in Pontocyprrella is larger than the right valve and sexual dimorphism is less pronounced.

Pontocyprrella harrisiana (Jones, 1849)

(pl.16, figs.8,9)

1849 Cythere (Bairdia) harrisiana Jones:25, pl.6, fig.17a-c(?d; non e, f)

1890 Bairdia harrisiana Jones; Jones & Hinde:8, pl.2, figs.52-55.

?1890 Bairdia harrisiana amplior Jones & Hinde:8, pl.2, fig.57, pl.4,  
fig.4

1962 Pontocyprrella harrisiana (Jones); Neale:431, pl.6, fig.12(?fig.13)

non1965a Pontocyprrella harrisiana (Jones); Kaye:73, pl.5, figs.3-4

1966 Pontocyprrella harrisiana (Jones); Gründel:17, pl.2, fig.9

1978 Dolocysteridea bosquetiana (Jones & Hinde): Van der Wiel: pl.2,  
fig.14

Diagnosis: A large species of Pontocyprrella with a bluntly rounded anterior margin and strongly assymmetric antero-dorsal and postero-ventral margins.

|                  | Length   | Height | Width |
|------------------|----------|--------|-------|
| 473a R.V. Female | 0.80m.m. | 0.36   | 0.15  |
| 474a L.V. Female | 0.78     | 0.36   | 0.17  |

Description: The left valve is sub-rectangular with a gently curved dorsal margin, the postero-dorsal margin is more strongly curved towards the bluntly rounded posterior extremity, at one fifth height. The greatest height occurs at one half length and the greatest width at two-thirds length. The right valve has a sinuous ventral margin and a weakly arched dorsal margin. In dorsal view the carapace is sub-ovate.

Remarks: The confused taxonomic history of this species is mainly caused by the lack of a lectotype, as the original figures (Jones, 1849) of this species probably also include three other species. Figures a-d (Jones, 1849) are from the 'chalk detritus' (Cenomanian) of Charing, Kent, and figs. e and f are from the Chalk of Charlton. Jones & Hinde (1890) refigured fig. f as a new species, Bythocypris reussiana. Fig. e is much shorter than the specimens from the 'chalk detritus' and cannot be considered conspecific. Jones & Hinde (1890) erected Bairdia harrisiana amplior from the 'Chalk of Kent', and also figured several specimens of which pl.2, fig.57 appears to be identical to that of Jones; pl.6, fig.17d.

Neale (1962) refigured two of the type specimens that had been illustrated by Jones (1849). These (figs.17c & f) Neale tentatively regarded as male and female specimens of P.harissiana. Sexual dimorphism was not recorded in the Albian specimens of this species. Neale also stated that the female (?) specimen (fig.19f) was of doubtful identity.

Kaye (1965c) figured specimens of P.harrisiana from the Middle Albian of Speeton. These do not appear conspecific with the original figures as they are shorter and higher. They are also shorter and higher than specimens from the Gault Clay of southern England. Kaye also stated that this species differs from P.semiquadrata Kaye, 1965 because it is larger, more elongate, the anterior margin bulges dorsally and the posterior margin bulges ventrally. However, Kaye did not record P.harrisiana from the Gault Clay, he only recorded P.semiquadrata.

Gründel recorded P.harrisiana (Jones, 1849) from the Middle and Upper Albian and Lower Cenomanian of Germany. His figured specimens resemble fig.17c of Jones (1849). Weaver (MS.) stated that the specimen refigured by Neale of Jones (pl.6,fig.17c) agrees in all respects with a group of specimens from the British Cenomanian. Albian specimens from southern England are similar to those of Weaver.

Stratigraphic conclusion: A taxonomically confused species which has been recorded from the Middle and Upper Albian and is of little stratigraphic value.

Pontocyprrella semiquadrata Kaye, 1965

(pl.16,fig.5)

1965c Pontocyprrella semiquadrata Kaye:224,pl.3,figs.1-8

1966 Pontocyprrella? semiquadrata Kaye;Gründel:17,pl.2,figs.10,11

Diagnosis: A sub-rectangular species of Pontocyprrella.

|  | Length | Height |
|--|--------|--------|
|--|--------|--------|

|                 |          |      |
|-----------------|----------|------|
| 185 R.V. Female | 0.89m.m. | 0.47 |
|-----------------|----------|------|

Description: A sub-rectangular species with a weakly convex dorsal margin, anterior margin semicircular and posterior margin bluntly rounded; ventral margin weakly concave; valves compressed, lateral surface smooth; greatest height and width at mid-length.

Remarks: This species was first described by Kaye (1965c) from the H.orbigny Subzone of Wrotham, Kent. It differs from P.harrisiana in being shorter, semiquadrate in outline, and has a greatly flattened anterior margin. Kaye remarked that this species occurs rarely in the upper part of the Lower Gault and more commonly in the Upper Gault. In the present study this species was recorded very rarely.

Stratigraphic conclusion: This species was recorded very rarely from the topmost C.auritus Subzone and from the S.dispar Zone. It is of limited stratigraphic value.

Subfamily MACROCYPRIDINAE Van Morkhoven, 1962

Genus Macrocypris Brady, 1867

Type species: Cythere minna Baird, 1850

Macrocypris sp.cf.M.siliqua (Jones, 1870)

(pl.15,figs.14,15;pl.16,figs.1,2)

1849 Cythere (Bairdia) siliqua Jones:25,pl.5,figs.16a-d (non. figs.  
16c-h)

1890 Macrocypris siliqua (Jones); Jones & Hinde:9,pl.2,figs.38-41

1964c Macrocypris siliqua (Jones); Kaye:43,pl.4,figs.11,14,15,18

Diagnosis: A species of Macrocypris with an evenly arched dorsal margin and drawn out posterior end.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 186 L.V. Female | 1.45m.m. | 0.49   | 0.23  |
| 187 -1 Juv.     | 0.91     | 0.30   | 0.18  |
| 188 R.V. Female | 1.14     | 0.32   |       |
| 189 R.V.Female  | 1.38     | 0.4    |       |

Description: A large species with a drawn out posterior end. The ventral margin is straight or slightly sinuous; the dorsal margin is arched; posterior extremely pointed; anterior margin broadly rounded. The greatest height occurs at mid-length, greatest width at mid-length; the lateral surface is smooth.

Remarks: This species was described by Jones from the 'chalk detritus' of Charing and from the Chalk of Gravesend. Jones & Hinde (1890) recorded it from several Chalk localities including the 'detritus' of Charing and from the Greensand of Ventnor, Isle of Wight. Kaye (1964c) resolved some of the taxonomic confusion by erecting a lectotype for this species from the 'detritus' of Charing and paralectotypes from the Chalk at Gravesend. Weaver (MS.) stated that his specimens from the Cenomanian of southern England

agree in all respects with the type material. He recorded it sporadically throughout the Cenomanian of southern England. The specimens recorded in this study have only been tentatively assigned to M.siliqua.

This species differs from M.simplex Chapman, 1898 in that it is larger, higher and has its greatest height at mid-length.

Stratigraphic conclusion: This species has only been recorded from the S.dispar Zone of southern and eastern England. It has been recorded sporadically throughout the Cenomanian and from the uppermost Albian. It is only of limited stratigraphic significance.

Family CYTHERIDAE Baird, 1850

Subfamily CYTHERINAE Van Morkhoven, 1962

Genus Dolocythere Mertens, 1956

Type species: Dolocythere rara Mertens, 1956

Dolocythere rara Mertens, 1956

(pl.16,fig.13)

1956 Dolocythere rara Mertens:192,pl.10,figs.33-37;pl.13,figs.91-93

1964b Dolocythere rara Mertens;Kaye:322,pl.55,figs.12,14,15

1966 Dolocythere rara Mertens;Gründel:24,pl.3,fig.29

Diagnosis: A small species of Dolocythere which has a strongly reticulate surface and a short postero-ventral marginal rib.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 191 Female L.V. | 0.34m.m. | 0.18   | 0.09  |

Description: Valves small, dorsal margin straight with a weak hinge ear antero-ventrally. The anterior margin is strongly rounded and in lateral view the ventral margin appears weakly concave. The posterior margin is bluntly rounded. A short postero-ventral marginal rib slightly projects in a ventral direction and partially obscures the ventral margin. This rib extends one quarter of the valve length. Valve weakly inflated with the greatest height at one sixth length and greatest width at mid-length. The mid lateral surface is covered by coarse reticulation with strongly developed pores which give a pitted appearance to this ornament. Posterior, anterior, and antero-ventral marginal areas are covered by much finer pitting.

Remarks: This species was first described from the Aptian and Lower Albian of northwestern Germany by Mertens (1956) who gave the Lower Albian as the type horizon. Kaye (1964b) recorded this species from the Bargate Beds of Surrey (Aptian) and Gründel recorded it from the Lower Albian of East Germany. In the present study this species

was only found commonly in the Lower Albian of Germany. However, it was also recorded in the S.dispar Zone of southern England and the southern North Sea Basin. It has not been recorded from the Cenomanian.

Stratigraphic conclusion: This species commonly occurs in the Aptian and Lower Albian where it is of stratigraphic significance. It also occurs in the S.dispar Zone where it is of limited stratigraphic significance.

Subfamily TRACHYLEBERIDINAE Van Morkhoven, 1962

Genus Cornicythereis Gründel, 1973

Type species: Cythereis cornuelli Deroo, 1956

Cornicythereis cornuelli (Deroo, 1956)

(pl.16, figs.10-12)

1954 Cythereis bonnemaï Triebel; Stchěpinsky:498, pl.22, fig.23

1956 Cythereis cornuelli Deroo:1518, pl.4, figs.59-61

1958 Cythereis cornuelli Deroo; Howe & Laurencich:190

Diagnosis: A large, strongly calcified, species of Cornicythereis with a prominent median rib.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 263 L.V. Female | 0.58m.m. | 0.36   | 0.15  |
| 264 L.V. Male   | 0.71     | 0.37   | 0.14  |
| 265 L.V. Male   | 0.56     | 0.32   |       |

Description: A large species with strongly converging dorsal and ventral margins. The anterior margin is broadly curved, the posterior margin bluntly rounded. Marginal denticulation is present antero-ventrally and along the posterior margin. A prominent, flattened, hinge ear is present. A smooth dorsal rib begins slightly posteriorly of this and extends to the postero-dorsal cardinal angle. This rib obscures the dorsal margin in lateral view. The inflated median rib extends from an inflated sub-central tubercule, it is half

the length of the valve and is parallel to the ventral margin. The ventral rib is smooth and extends from the antero-ventral margin, it diverges slightly from the ventral margin and extends two-thirds the length of the valve. A rib parallel to, and slightly inset from, the anterior margin extends from the hinge ear to merge with the ventral rib. Males are much longer and more rectangular than females. Lateral surface smooth.

Variation: This species decreases in size through the Middle Albian Gault Clay facies of southern England. A closely related species, C. sp.aff. C. cornuelli, which is larger and differs slightly in appearance occurs in the marginal facies (Upper Albian) of Seaton and Cauville.

Remarks: Deroo (1956) described this species from the D. mammillatum Zone of the Paris Basin. He included the forms of Stchépinsky from the Upper Albian of Haute Marne (Côtes Noires) in his original description. Damotte (1971b) recorded this species from the D. mammillatum and H. dentatus Zones of the Paris Basin. Damotte (fig.8) also suggested that this species evolved into C. glabrella Triebel, 1940 in the Upper Albian. During the Middle Albian this species evolves to C. larivourensis in the Gault Clay facies of the Anglo-Paris Basin, and to C. sp.aff. C. cornuelli in the marginal Upper Greensand facies.

Stratigraphic conclusion: This species occurs commonly in the Lower Albian and lower Middle Albian of the Anglo-Paris Basin. It is last recorded in the A. intermedius Subzone and is an important stratigraphic marker.

Cornicythereis sp. aff. C. cornuelli Deroo, 1956  
(pl.17, fig.1)

Diagnosis: A large heavily calcified species of the genus Cornicythereis.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 472 L.V. Female | 0.84m.m. | 0.45   | 0.20  |



Description: This species has three, inflated, longitudinal ribs and a small hinge ear. In outline it appears sub-rectangular and is relatively inflated.

Remarks: This species is similar to C.cornuelli but differs in being larger, less high and more rectangular. The hinge ear is not as rounded but the antero-ventral margin is more acutely rounded. It was only recorded in the marginal Upper Greensand facies of the Anglo-Paris Basin. It occurs very sporadically in the S.dispar Zone and may have evolved from the C.cornuelli/C.larivourensis group.

Stratigraphic conclusions: A rare species which has only been recorded from the S.dispar Zone of the Anglo-Paris Basin. Of limited stratigraphic value.

Cornicythereis bonnemai Triebel, 1940

(pl.17,figs.3,4,6)

1940 Cythereis bonnemai Triebel:204,pl.7,figs.67-70

1962 Cythereis bonnemai Triebel;Ellermann:402

1966 Cythereis bonnemai Triebel;Gründel:33,pl.6,fig.5

1978 Cythereis bonnemai Triebel;Neale:pl.12,figs.5,6

Diagnosis: A small, elongate, poorly inflated species of Cornicythereis with three poorly developed pointed ribs.

|                   | Length   | Height | Width |
|-------------------|----------|--------|-------|
| 266 L.V. Female   | 0.59m.m. | 0.36   | 0.18  |
| 267 R.V. Male     | 0.69     | 0.37   | 0.15  |
| 268 Male Carapace | 0.60     | 0.31   | 0.12  |

Description: A small, smooth species with three poorly developed longitudinal ribs on the lateral surface. The hinge is poorly developed, the dorsal margin is straight, and the ventral margin is slightly concave. These margins converge strongly towards the triangular

posterior margin. The anterior margin is semi-circular with a frill extending its length in a dorsal direction. The median and ventral ribs are parallel to the ventral margin, the dorsal rib converges posteriorally with the median rib where the two are almost connected by a short bar extending from the posterior end of the dorsal rib. The male is much longer than the female.

Remarks: Triebel (1940) first recorded this species from the N.minimus Zone of Germany. Gründel (1966) recorded this species ranging through the Middle and Upper Albian to the Lower Cenomanian. He also placed C.larivourensis Damotte & Grosdidier, 1963 in the synonymy of this species. He gave no evidence or explanation for this statement and he did not record C.cornuelli. C.bonnemai and C.larivourensis are regarded as distinct because C.bonnemai is longer, less high and more 'graceful' than C.larivourensis. These two species also have geographically mutually exclusive distributions during the Albian.

Neale (1978) recorded this species in the Middle and Upper Albian of Yorkshire and Germany. In the present study this species was also recorded from the Upper Albian and the topmost Middle Albian of the southern North Sea Basin. It was recorded more abundantly in the Upper Albian, especially in the S.dispar Zone.

Stratigraphic conclusion: This species has been recorded in the Middle and Upper Albian of the southern North Sea and German Basins. It occurs commonly but is geographically limited in distribution to the 'boreal' province. It is of limited stratigraphic value.

Cornicythereis gatyensis Damotte & Grosdidier, 1963

(pl.17, figs.2,5)

1963 Cythereis? gatyensis Damotte & Grosdidier:58

1963d Cythereis lamplughi Kaye:236,pl.19,figs.14-16

1965b Cythereis lamplughi Kaye;Kaye:46,pl.7,figs.14,15

1966 Cythereis gatyensis Damotte & Grosdidier;Gründel:34,pl.6,fig.6

1971b Cornicythereis gatyensis Damotte & Grosdidier;Damotte:63,pl.2,  
fig.8

1978 Rehacythereis gatyensis (Damotte & Grosdidier);Neale:pl.11,  
figs.11,12

Diagnosis: A small species of Cornicythereis with a discontinuous median rib.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 269 R.V. Female | 0.53m.m. | 0.30   | 0.11  |
| 270 L.V. Female | 0.53     | 0.32   | 0.13  |

Description: A small, subrectangular species, which is similar in outline to the other species of this genus. The dorsal longitudinal rib is corrugated in appearance, the median rib is discontinuous and is formed of two slightly elongated nodes. Marginal denticulation is present antero-ventrally and postero-ventrally. The lateral surface is smooth.

Remarks: Damotte & Grosdidier (1963) described this species from the H.dentatus Zone of the Paris Basin. Kaye (1963d) also recognised this as a distinct species which he named C.lamplughi. The name of Damotte & Grosdidier takes precedence. Kaye recorded this species from the Lower and Upper Aptian and the H.spathi Subzone of England. However, Damotte (1971) did not record this species from the Aptian and only recorded it from the Lower and lower Middle Albian of the Aube. She also postulated a phylogenetic lineage for this species which evolved from the Aptian C. lovemontensis and into the Upper Albian C.larivourensis. This lineage does not explain Kaye's Aptian record of C.gatyensis, which indicates that this species clearly evolved earlier than the Albian. The postulated sequence from C.gatyensis to C.larivourensis is also problematical as in this study C.larivourensis

has been shown to evolve from C. cornuelli. This species has also been recorded from the southern North Sea Basin where it occurs in the Middle Albian clays. Gründel (1966) has recorded it from the basal Middle Albian of East Germany. However, he incorrectly included C. nuda Deroo, 1956 in his synonymy. This latter species was recorded by Deroo from the Lower and Middle Cenomanian and should more correctly be referred to Cythereis paranuda Weaver (MS.).

Stratigraphic conclusion: This species occurs in the Aptian, Lower and Middle Albian. It appears to be ubiquitously distributed in the Albian but only occurs very rarely. It is of limited stratigraphic value.

Cornicythereis larivourensis Damotte & Grosdidier, 1963

(pl.16, figs.14-18)

1963 Cythereis? larivourensis Damotte & Grosdidier: 59, pl.3, figs.9a-i

1971b Cornicythereis larivourensis Damotte & Grosdidier; Damotte:

65, pl.2, fig.12

1978 Cornicythereis larivourensis Damotte & Grosdidier; Van der Wiel:

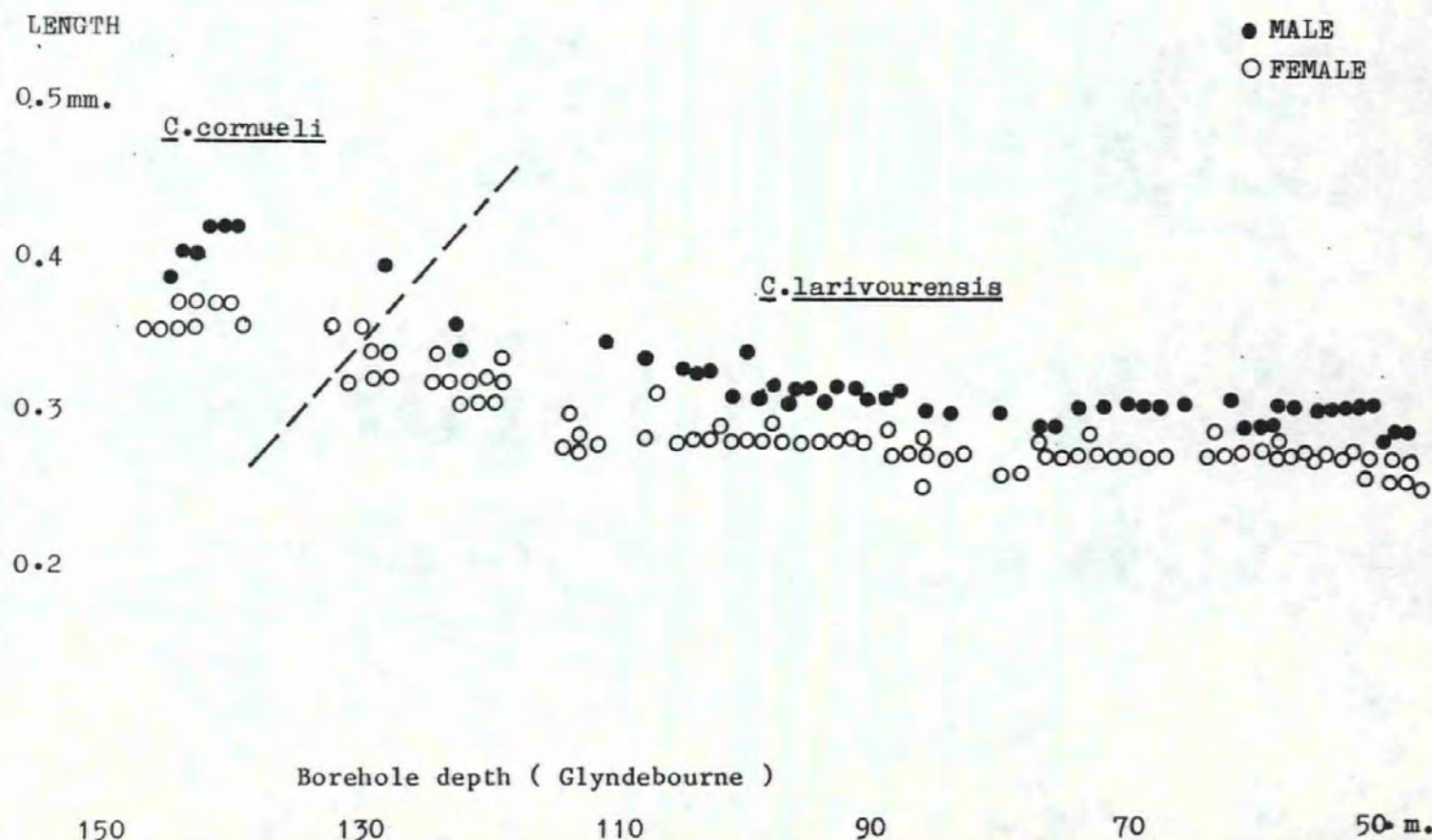
pl.1, figs.9,10

Diagnosis: A small species of Cornicythereis with a broadly rounded hinge ear.

|                      | Length   | Height | Width |
|----------------------|----------|--------|-------|
| 271 L.V. Female      | 0.52m.m. | 0.30   | 0.12  |
| 272 R.V. Female      | 0.52     | 0.29   | 0.14  |
| 273 L.V. Male        | 0.55     | 0.31   | 0.12  |
| 274 Dorsal Male C.   | 0.55     |        | 0.20  |
| 275 Dorsal Female C. | 0.48     |        | 0.20  |

Description: A small species with three prominent longitudinal ribs. The dorsal and ventral margins converge strongly towards the posterior, the anterior margin is broadly rounded and the posterior

Fig. 5:1 The variation in length of two species of the genus Cornicythereis in the Middle and Upper Albian.



margin triangular. Marginal denticulation is present along the posterior margin but is poorly developed anteriorly. A marginal, dorsally directed frill is present along the dorsal margin. The sub-central tubercle is slightly inflated. All the ribs tend to be ridged and not rounded, the median rib extends half the valve length and at the posterior end of the dorsal and ventral ribs short bar-like extensions are directed inwards. An anterior marginal rib extends from the hinge ear to join the anterior end of the ventral rib. The lateral surface is smooth.

Variation: This species gradually becomes smaller (fig.5:1) during the Upper Albian. It also becomes less heavily calcified and the ribs become more sharply defined.

Remarks: This species was first described by Damotte & Grosdidier (1963) from the Paris Basin. They recorded the Lower Cenomanian (M.inflatum Zone) as the type horizon. Damotte (1971b) recorded it as ranging from the M.inflatum Zone to the M.mantelli Zone. Gründel (1966) preferred to regard this species as synonymous with C.bonnemai; he did not record any specimens of C.larivourensis from Germany and gave no evidence for his conclusion. Damotte (1971b) preferred to retain these as separate species since they differ markedly in size, especially in their length:height:width ratios. Damotte also postulated that this species evolved from C.gatyensis in the Middle Albian. In this account it has been shown (fig.5:1) that this species is directly related to, and has evolved from, C.larivourensis. These two species show much greater morphological similarity than do C.cornuelli and C.gatyensis. C.larivourensis also appears to be geographically restricted to the Anglo-Paris Basin. It was never found in association with C.bonnemai.

Van der Wiel (1978) recorded this species from the D.cristatum to the C.auritus Subzones of Wissant and Weaver (MS.) has recorded it from the Lower and Middle Cenomanian of southern England.

Stratigraphic conclusion: This species first occurs in the

D.niobe Subzone of southern England and ranges through to the Cenomanian.  
It occurs abundantly and is an important stratigraphic marker.

Genus Cythereis Jones, 1849

Type species: Cythereis ciliata Reuss, 1846

Cythereis folkestonensis Kaye, 1964

(pl.18,figs.11,13)

1849 Cythere (Cythereis) quadrilaterata (Roemer); Jones:18,pl.3,  
figs.a-c,e

1890 Cythere quadrilaterata (Roemer); Jones & Hinde:20,pl.1,figs.  
69-71,74,75

1964c Cythereis folkestonensis Kaye:63,pl.7,figs.1-5

1978 Cythereis folkestonensis Kaye; Van der Wiel:pl.4,figs.13-15

Diagnosis: A large species of Cythereis with four poorly  
developed longitudinal rows of tubercules and smooth intercostal areas.

|                           | Length   | Height | Width |
|---------------------------|----------|--------|-------|
| 222 L.V. Male             | 1.05m.m. | 0.67   | 0.34  |
| 223 Dorsal,Female,L.V.O.9 |          |        | 0.26  |

Description: An inflated,subrectangular species with straight  
dorsal and ventral margins which converge posteriorally. The lateral  
surface is smooth and is traversed by three longitudinal rows of  
tubercules. The ventral rib consists of six to seven tubercules, the  
median rib is much reduced and consists of three to four reduced,  
partially fused, tubercules. The sub-central tubercule is prominent  
and smooth. The anterior margin is bluntly rounded, the posterior  
margin is obtusely pointed. At the posteroventral margin a prominent  
cardinal angle is present. Marginal denticules occur along the entire  
lengths of the anterior and posterior margins. A hinge ear occurs at  
the junction of the anterior and dorsal margins, inset from this a  
prominent eye tubercule is present. A short rib extends from the eye

tubercule in a ventral direction. The male differs by being much longer than the female. The greatest width is at mid-length. Juveniles-1 are smooth or weakly reticulate with a weak, ventral, longitudinal rib.

Variation: This species is separated from the main C.hirsuta Damotte & Grosdidier, 1963 plexus by being completely smooth. It also exhibits some variation in size (fig.5:2), but this is minimal when compared to other species of Cythereis.

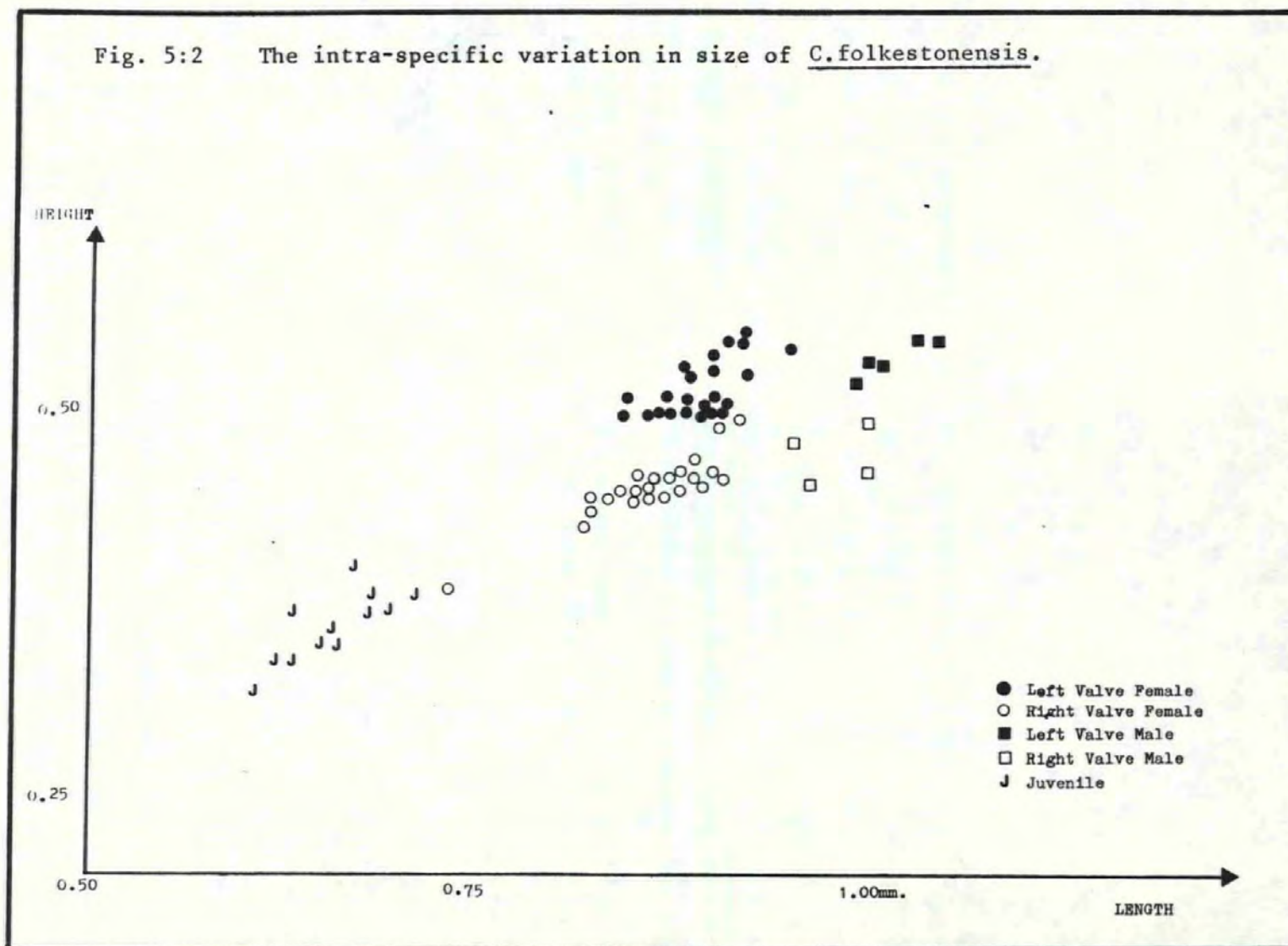
Remarks: Jones (1849) recorded this species from the Albian. However, he created a large amount of taxonomic confusion which was largely resolved by Kaye (1964c) when he erected a lectotype from the Gault Clay of Folkestone. Kaye noted that this species appears to be limited in distribution to the Albian. He defined this species on the presence of three longitudinal rows of tubercules and a lateral surface devoid of reticulation, with a prominent sub-central tubercule.

Van der Wiel (1978) studied this species in detail and concluded that transitional forms exist between C.reticulata and C.folkestonensis. He reserved the name C.folkstonensis for specimens with their lateral surface completely devoid of reticulation, and in doing this he followed the original definition of Kaye. He also revised the species concept of this plexus and proposed that this species evolved from C.reticulata. In the present study many intermediate specimens between C.hirsuta and C.folkestonensis were recorded. These two species occur in close association, but never in association with C.reticulata (Jones & Hinde, 1890) which last occurs in the Middle Albian. C.folkestonensis is clearly closely related to C.hirsuta. This subject is further discussed in the concluding chapters.

In the present study this species has only been recorded from the base of the H.orbigny Subzone to the middle of the C.auritus Subzone. It has only been recorded from southeast England and northwestern France.



Fig. 5:2 The intra-specific variation in size of C.folkestonensis.



Stratigraphic conclusion: This species occurs commonly in the lower part of the Upper Albian, but has only been recorded from southern England and northwestern France where it is of zonal significance.

Cythereis sp.aff. C.folkestonensis Kaye, 1964

(pl.18,fig.10)

Diagnosis: A moderately sized species of Cythereis with a smooth lateral surface and a smooth, weakly developed, sub-central tubercule.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 224 R.V. Female | 0.80m.m. | 0.45   | 0.25  |

Description: A moderately sized species with straight dorsal and ventral margins. The anterior margin is weakly curved and the posterior margin is triangular with a prominent marginal shelf. Valves inflated; greatest height at one fifth length. Postero-ventral cardinal angle is prominent. A small eye tubercule is present antero-dorsally. The lateral surface is smooth with a smooth sub-central tubercule. Three poorly developed longitudinal ribs are present which all consist of a number of short isolated spines. The median rib consists of five spines, the dorsal rib of five and the ventral rib of seven. Marginal denticulation is present anteriorally and postero-ventrally, eleven denticules anteriorally and four posteriorally.

Remarks: This form has been separated from C.folkestonensis on the basis of the disparity in size between the two forms and the lack of intermediate size groups (fig.5:2). It was recorded very rarely in association with C.folkestonensis. It approximates in size to the juvenile specimens of C.folkestonensis (fig.5:2) but shows all the adult characteristics. It appears to be an example of early maturation which conforms to a simple arithmetic ratio.

Stratigraphic conclusion: A rare species of limited stratigraphic value.

Cythereis glabrella Triebel, 1940

(pl.18,figs.14,15)

1940 Cythereis glabrella Triebel:196,pl.6,figs.60-62

1964a Cythereis glabrella minuera Triebel;Gründel:746,pl.1,figs.1,2

1965c Cythereis glabrella Triebel;Kaye:248,pl.10,figs.5-8

1966 Cythereis glabrella glabrella Triebel;Gründel:34,pl.6,figs.12,13;  
pl.10,fig.2

1966 Cythereis glabrella minuera Triebel;Gründel:34,pl.6,figs.14,15

1971b Cythereis glabrella Triebel;Damotte:68,pl.3,fig.2

1978 Rehacythereis glabrella (Triebel);Neale:pl.12,figs.3,4

Diagnosis: A flattened species of Cythereis with a smooth lateral surface and three smooth longitudinal ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 225 L.V. Female | 1.08m.m. | 0.64   | 0.26  |
| 226a L.V. Male  | 1.12     | 0.66   |       |

Description: A sub-rectangular species with straight dorsal and ventral margins which converge posteriorally. The lateral surface is smooth and bears a smooth poorly developed sub-central tubercule and three poorly developed longitudinal ribs which are rounded and smooth. The posterior ends of the dorsal and ventral ribs are more distinct and have short extensions towards the median rib. The anterior margin is gently curved with a more steeply curved antero-ventral margin. The posterior margin is obtusely pointed with a prominent postero-dorsal cardinal angle. Along the antero-ventral and postero-ventral margins denticulation is present. The hinge ear is flattened. The eye tubercule is poorly developed; intercostal areas smooth.

Remarks: Triebel (1940) first recorded this species from the N.minimus Zone of northwest Germany. Gründel (1964a) erected a new subspecies, C.glabrella minuera, based on the reduction in prominence

of the middle rib and of the muscle node. He recorded this subspecies from the lower Upper Albian of Germany, and claimed that it evolved from the Middle Albian, C. glabrella glabrella, by decreasing the height of the node. He also indicated that this change is associated with an overall decrease in size of this species. The present author prefers to regard the decrease in size of any specific morphological feature as being the result of the decrease in overall size of this species and not vice versa as Gründel infers.

Kaye (1965c) was the first to record that this species is not common in the Gault Clay of southern England (in the present study it was not recorded from this facies). However, he did record it from the marginal facies of Pinhay, Devon and from the Red Chalk of Yorkshire. Damotte (1971b) recorded a similar form from the Cenomanian of the Paris Basin. She stated that these Cenomanian forms clearly resemble the German forms and that she regarded the differences as small and not great enough to warrant the erection of a new subspecies. However, Weaver (MS.) did not record this species from the Cenomanian of southern England. The record of Damotte may indicate a 'boreal' invasion into the Paris Basin during the Cenomanian.

Stratigraphic conclusion: This species occurs sporadically in the Middle and Upper Albian of the southern North Sea and German Basins. It is of limited stratigraphic value.

Cythereis hindei hindei Weaver, MS.

(pl.19, figs.1-4)

?1849 Cythereis ciliata Reuss; Jones:19, pl.4, fig.11h' (non figs.11a-h)

?1890 Cythereis ornatissima Reuss; Jones & Hinde:21, pl.2, fig.16, pl.4, fig.8 (non pl.2, figs.1-7, 15; pl.4, fig.7)

Diagnosis: A small species of Cythereis with a smooth lateral surface and a prominent, smooth, sub-central tubercle.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 227 L.V. Female | 0.58m.m. | 0.34   | 0.19  |
| 228 R.V. Male   | 0.62     | 0.33   | 0.15  |
| 229 L.V. Female | 0.63     | 0.34   | 0.18  |
| 230 R.V. Female | 0.63     | 0.32   | 0.20  |

Description: A sub-rectangular species with a straight dorsal margin. The anterior margin is broadly rounded; ventral margin gently curved and terminates at the posterior extremity which is blunt. A prominent postero-dorsal cardinal angle connects the straight dorsal and straight postero-dorsal margins. Antero-ventrally twelve to fifteen marginal denticles are present, posteriorly several spines protrude from the valve margin. The hinge ear is small. The eye tubercle is large. The intercostal areas are smooth with some faint ribbing between the large smooth sub-central tubercle and the anterior marginal rib. The three longitudinal ribs are discontinuous and are formed of small stubby spines.

Remarks: The figured specimen of Jones (1849) was collected from the Gault Clay at Folkestone. The figures of Jones (1849) and Jones & Hinde (1890) were included in the synonymy of this species by Weaver (MS.). Jones (1849) clearly figured a specimen of C.lurmannae (pl.4, fig.h) which is only marginally longer than fig.h (? C.h.hindei). However, C.lurmannae is always larger than C.h.hindei and hence this figured specimen may not be C.h.hindei. Since only a dorsal view is figured no conclusions can be reached.

Weaver (MS.) recorded this subspecies from the Lower and Middle Cenomanian up to the level of the mid-Cenomanian non sequence (Carter & Hart, 1977). In the Albian this species has only been recorded from the S.dispar Zone of southern England. It is often found in association with Cythereis sp.A.sp.nov., which it resembles closely. It differs from the latter mainly in the presence of marginal

denticulation along the whole dorsal margin whereas Cythereis sp.A.sp.nov. has five antero-ventral denticules.

Stratigraphic conclusion: This species occurs sporadically in the S.dispar Zone of southern England and ranges through into the Cenomanian. It is of local stratigraphic significance.

Cythereis hirsuta Damotte & Grosdidier, 1963

(pl.17,figs.8,10-15;pl.18,figs.1,2,4,7,8)

1956 Cythereis reticulata Jones & Hinde;Deroo:1518,pl.5,figs.70,73,76

1963 Cythereis hirsuta Damotte & Grosdidier:56,pl.2,figs.5a-g

non1964a Cythereis hirsuta Damotte & Grosdidier;Gründel:pl.1,figs.6,7

1964c Cythereis thoerenensis Triebel;Kaye:68,pl.7,figs.15,17

non1966 Cythereis hirsuta Damotte & Grosdidier;Gründel:35,pl.6,figs.16,20

1971b Cythereis hirsuta Damotte & Grosdidier;Damotte:65,pl.2,fig.11

1978 Cythereis hirsuta Damotte & Grosdidier;Van der Wiel:pl.3,figs.5-15;pl.4,figs.2-8,10-12.

Diagnosis: A large, spinose, species of Cythereis.

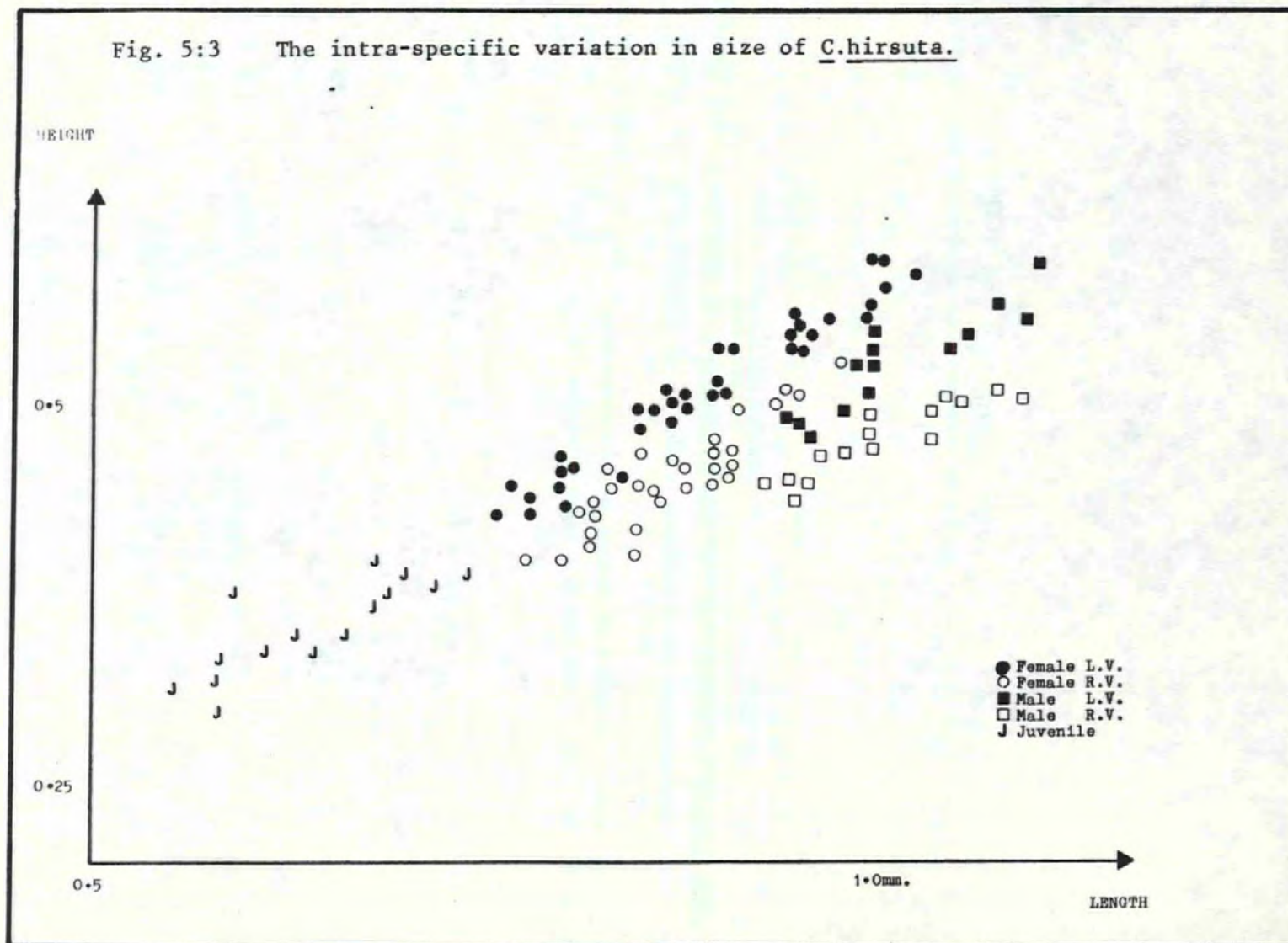
|                   | Length   | Height | Width |
|-------------------|----------|--------|-------|
| 231 L.V. Female   | 1.10m.m. | 0.67   | 0.38  |
| 232 L.V. Female   | 1.0      | 0.57   |       |
| 233 L.V. Dorsal   | 1.03     |        | 0.33  |
| 234 R.V. -1       | 0.90     | 0.51   | 0.26  |
| 235 R.V. Female   | 1.02     | 0.52   | 0.40  |
| 236 L.V. Male     | 1.11     | 0.58   | 0.41  |
| 237 R.V. Hinge    |          |        |       |
| 238 L.V. Female   | 1.00     | 0.56   | 0.26  |
| 239 R.V. Male     | 1.03     | 0.53   | 0.27  |
| 240 Dorsal Female | 1.11     | 0.59   |       |

Description: A strongly calcified, inflated, subrectangular species which has three poorly developed longitudinal ribs on its lateral surface. These consist of a number of separate spines. The lateral surface is covered by a strong reticulation; a well developed sub-central tubercle has a crown of spines. The hinge ear is poorly developed and the eye tubercle is well developed. The anterior margin is broadly rounded; posterior margin obtusely pointed; both margins bear marginal denticulation. Juveniles -1 have spinose dorsal and ventral ribs and are covered by weak reticulation. Males are longer than females.

Variation: This species varies greatly in size and in degree of ornamentation and is closely related to both C.folkestonensis and C.reticulata. Specimens which occur directly below the D.cristatum nodule bed are similar in appearance to C.reticulata, these specimens have longitudinal ribs consisting of poorly developed spikes. In the lower Upper Albian this species tends to lose its reticulation and become smooth. The extreme form of this is C.folkestonensis. All intermediates between these two species occur in the H.orbigny Subzone although in the high H.varicosum Subzone the two populations have become more distinct. This variation is also visible on the -1 juveniles of this species. Higher in the Albian specimens become coarsely spinose. These spines are terminally bifurcating and they occur at the junctions of the reticulation.

This species also varies greatly in size (fig.5:3). Males only occur in association with the largest sized population; in the smaller sized populations adults are all female. This indicates that this species probably reproduced both syngamically and partheno-genetically. Fig.5:3 also illustrates the nature of the size variation which appears to be gradational, although poorly defined size groups may be present. In either case this variation in size does not conform to Copes Rule.







Remarks: This species, mainly due to its variability, has a confused taxonomic history. It was originally figured by Chapman & Sherborn (1893) from the Gault Clay of Folkestone where they recorded it from Bed x. They named it after a species that had earlier been described by Jones & Hinde (1890). It was not recognised as a distinct species until the work of Damotte & Grosdidier (1963). Unfortunately their definition created problems since they figured the holotype (pl.2, fig.5a) which they state to be a male carapace. From the figure this appears to be a -1 juvenile and not an adult.

Gründel (1964, 1966) recorded specimens with frilly spines and included them in this species, and this view was endorsed by Damotte (1971b). In the present study these specimens are regarded as intermediates between C.hirsuta and C.reticulata Jones and Hinde, 1890 and have been included in the synonymy of the latter. C.hirsuta has been recorded only when these spikes have evolved into distinct spines. This change is gradational. Both Gründel (1966) and Damotte (1971b) regarded the specimen of C.thoerenensis Triebel, 1940 which Kaye (1964c) figured as synonymous with this species. This is incorrect as this specimen is very similar to the original figures of Triebel. It has also been shown that C.thoerenensis is a separate species (fig.5:3) thus proving the correct assignation of Kaye. The spiny S.dispar Zone specimens of C.hirsuta are larger than C.thoerenensis which is only poorly spinose. The latter also reproduces syngamically whereas smaller specimens of C.hirsuta do not. Damotte (1971b) recorded this species from the Upper Albian and Lower Cenomanian and Gründel recorded it ranging from the Middle Albian to Lower Cenomanian..

Van der Wiel (1978) further confused this species with the application of the concept of form groups. He figured many specimens (pl.4, figs.2-8) which are very similar to the original figures of Damotte and Grosdidier (1963). He also figured specimens as C.reticulata (pl.3, figs.5-15) which belong to this species. He also

thought that C.folkestonensis evolved from C.reticulata, this was not observed in the present study where it was recorded that C.folkestonensis is very closely related to C.hirsuta and clearly evolved from the latter.

Weaver (MS.) recorded this species as sporadic in the Lower Cenomanian and noted that Cenomanian specimens of this species are smaller.

Stratigraphic conclusion: This species occurs commonly in the upper Middle and Upper Albian and ranges through into the Cenomanian. It first appears at the base of the D.niobe Subzone. It appears to be mainly limited in distribution to the Anglo-Paris Basin where it is of moderate stratigraphic significance.

Cythereis ex.gr. C.lurmannae Triebel, 1940

(pl.19,figs.5-13,16,17;pl.20,figs.3,4,15)

1940 Cythereis lurmannae Triebel:201,pl.6,figs.63-66

1956 Cythereis lurmannae Triebel;Deroo:1516

1964c Cythereis lurmannae Triebel;Kaye:66,pl.8,figs.11-15

1966 Cythereis lurmannae Triebel,Gründel:36,pl.6,fig.23

1971b Cythereis lurmannae Triebel;Damotte:66,pl.2,figs.13a-c

1971 Cythereis lurmannae lurmannae Triebel;Kemper:37,pl.1,figs.1,2,  
5,6

1971 Cythereis lurmannae bemerodensis Triebel;Kemper:39,pl.1,figs.3,4

1971 Cythereis lurmannae hannoverana Triebel;Kemper:38,pl.1,figs.7,8

1978 Cythereis lurmannae Triebel;Van der Wiel:pl.1,figs.7,8

Diagnosis: A large dorsally flattened species of Cythereis which has a poorly developed median rib and strongly converging dorsal and ventral margins.

|     |           | Length   | Height | Width |
|-----|-----------|----------|--------|-------|
| 242 | L.V. Male | 0.81m.m. | 0.48   | 0.20  |

|      |                  |      |      |      |
|------|------------------|------|------|------|
| 243  | L.V. Male        | 0.87 | 0.51 | 0.23 |
| 244  | R.V. Female      | 0.71 | 0.41 | 0.18 |
| 245  | L.V. Female      | 0.75 | 0.46 | 0.19 |
| 246  | L.V. Female      | 0.74 | 0.46 |      |
| 247  | L.V. Male        | 0.80 | 0.46 | 0.17 |
| 248  | R.V. Male        | 0.82 | 0.38 | 0.15 |
| 249  | L.V. Male        | 0.78 | 0.44 | 0.17 |
| 250  | L.V. Female      | 0.84 | 0.45 | 0.20 |
| 251  | L.V. Male        | 0.81 | 0.42 |      |
| 252  | L.V. Female      | 0.79 | 0.46 | 0.2  |
| 251a | Dorsal Male C.   | 0.81 |      | 0.34 |
| 252a | Dorsal Female C. | 0.82 |      | 0.36 |

Description: A sub-triangular species with strongly converging dorsal and ventral margins, the dorsal margin is straight, the ventral margin is slightly concave. The anterior margin is broadly rounded, the posterior margin is triangular. A prominent hinge ear tends to be flattened while strong postero-dorsal cardinal angles are present at either end of the dorsal margin. A moderately sized eye tubercle has a short rib extending from its ventral margin. Marginal denticulation is present around the anterior margin and around the postero-ventral margin. The sub-central tubercle is prominent and smooth, posteriorly to this a short median rib is present, this is formed of one or two small nodes. The dorsal and ventral ribs are strongly developed and are pointed. At their posterior extremities short bars extend inwards. The intercostal areas are reticulate and a secondary finer reticulation is present within the primary. The right valve lacks a hinge ear. Males are much longer than females.

Variation: This is a very variable species which generally becomes smaller and less strongly reticulate during the Upper Albian. The loss of the primary reticulation gradually reveals the secondary reticulation. This change continues in some specimens from the

S.dispar Zone of the Red Chalk province which have become completely smooth, having lost all their secondary reticulation.

The size of this species is also variable. The overall size of specimens shows no arithmetic control and does not conform to Copes Law (fig.5:4). The length/height ratio is also very variable as is the male/female size ratio (fig.5:4).

Remarks: Triebel (1940) first described this species from the N.minimus Zone of northwest Germany. Since this description, C.lurmannae, has been documented frequently but poorly understood.

Deroo (1956) recorded it from the Vraconian to the mid-Cenomanian of northern France. Kaye (1964c) discussed the work of Jones & Hinde (1890) and concluded that they figured this species in so many different contexts that Triebels' name is much better upheld. Gründel recorded it ranging from the Middle Albian to the Lower Cenomanian of East Germany. Damotte (1971b) recorded it rarely from the M.inflatum Zone.

Kemper (1971) suggested that this species should be divided into three subspecies which he regarded as chronosubspecies and utilised in his zonal scheme for the Albian of the Hannover district of Germany. He regarded C.l.lurmannae as ranging from the base of the D.cristatum Subzone to the top of the H.varicosum Subzone; C.l.hannoverana from the top two thirds of the M.inflatum Zone and C.l.bemerodensis from the S.dispar Zone. In separating these subspecies he was the first author to document the degree of variation which this species exhibits. Each of these subspecies is discussed in detail below:

Cythereis lurmannae lurmannae

The figured and measured specimens of Kemper differ in length from the original specimen of Triebel:

|                | Female L.V. | Male L.V. |
|----------------|-------------|-----------|
| Triebel (1940) | 0.78 m.m.   | 0.88      |
| Kemper (1971)  | 0.84        | 0.87      |

Thus, the female figured by Kemper is almost as large as the male and is considerably larger than the female originally figured by Triebel. The specimens in this study are mostly comparable to the measured specimens of Triebel and Damotte (fig.5:4).

Cythereis lurmannae hannoverana

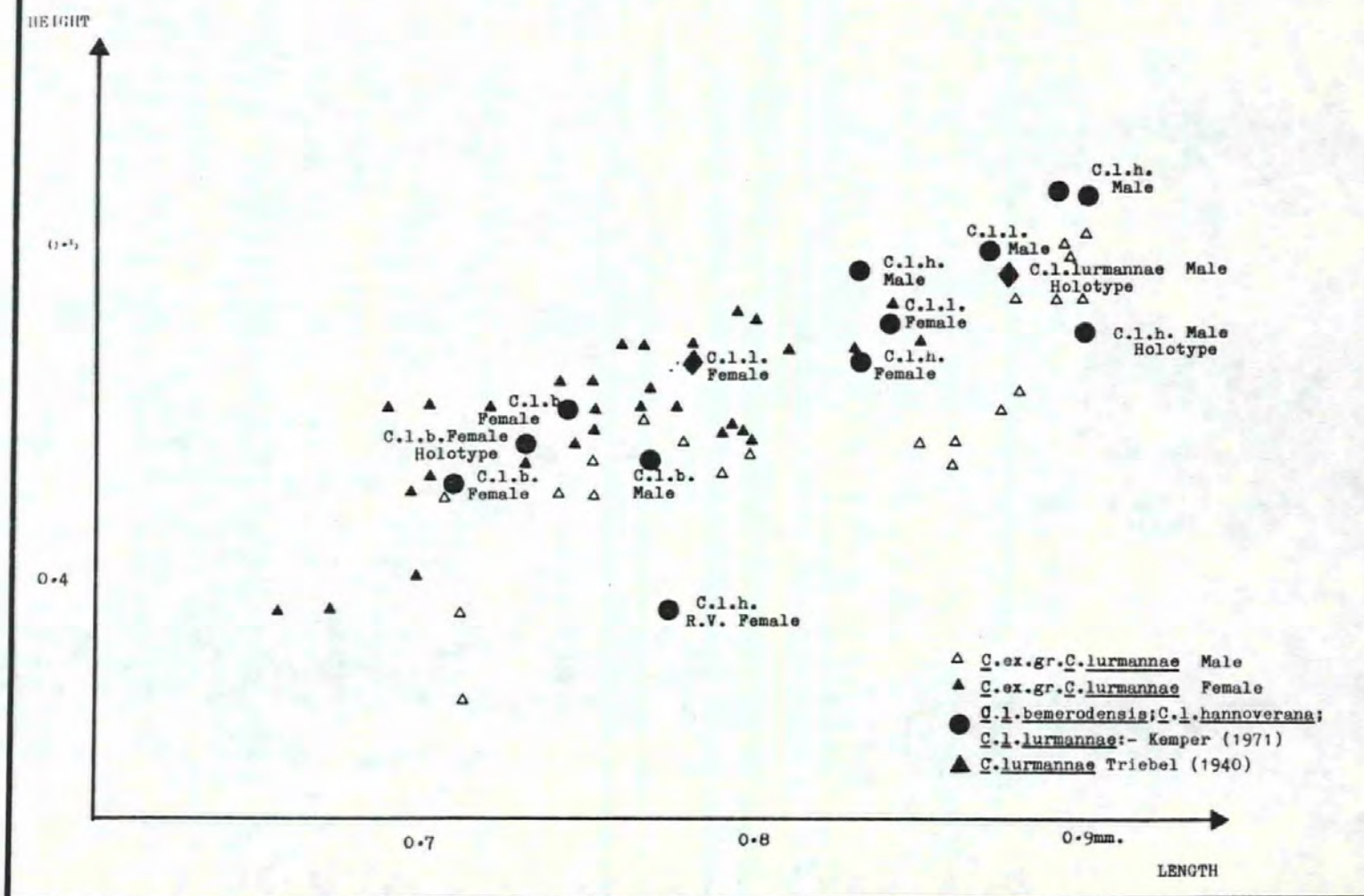
This subspecies is the same length but higher than any of the specimens (fig.5:4) recorded in this study. It has retained a prominent hinge ear but has lost all primary and secondary reticulation. Specimens similar to this occur in the Red Chalk (S.dispar Zone), these differ in being much less high (fig.5:4) and in lacking the short rib which extends ventrally from the eye tubercle. These specimens cannot be directly related to the specimens of Kemper and do not occur at the same stratigraphic horizon.

Cythereis lurmannae bemerodensis

This subspecies has lost all but some faint secondary reticulation and has a weak hinge ear. It is very similar to specimens recorded by Weaver (MS.) from the Cenomanian of southern England. It is very similar in size (fig.5:4) to many specimens from the S.dispar Zone of England but differs in its shape and ornamentation. Nothing closely resembling this subspecies has been recorded in this study. This subspecies has a very diachronous first occurrence and can only be regarded as of limited stratigraphic value.

The specimens of Kemper have been compared with those recorded in the present study to illustrate the total variation in size. If the criteria that Kemper applied to his specimens to define subspecies were applied to the total population then several other subspecies must also be defined. The present author would prefer to regard this species as very variable, similar to many other species of Albian Cythereis.

Weaver (MS.) also recorded C.l.lurmannae from the Lower



Cenomanian locality in southern England. This, and the presence of C.l.bemerodensis in the Cenomanian of southern England, indicates that both vertical and lateral changes in this species plexus occurred. Therefore, these changes should be regarded as of very limited stratigraphic importance.

Kaye & Barker (1965) recorded Cythereis sutterbyensis Kaye & Barker, 1965 from the Upper Albian of Lincolnshire. However, this species has not been recorded from the Albian and hence the morphological similarity of this species to C.lurmannae indicates that it is an ancestral form.

Stratigraphic conclusion: This species appears commonly in the upper Middle and Upper Albian of England and ranges through into the Cenomanian. It first occurs at the base of the D.niobe Subzone and is of moderate stratigraphic significance.

Cythereis pinhayensis Kaye, 1965

(pl.18,fig.12)

1965c Cythereis pinhayensis Kaye:248,pl.9,figs.1-8

Diagnosis: A small, strongly calcified, species of Cythereis which lacks spines and has a prominent eye tubercule.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 254 L.V. Female | 0.90m.m. | 0.49   | 0.23  |

Description: A subrectangular species which has straight dorsal and ventral margins which converge slightly towards the posterior. The anterior margin is broadly rounded with a distinct antero-dorsal cardinal angle. The hinge ear is very small. The posterior margin is triangular. Marginal denticulation is weak dorsally but very strong postero-dorsally. The lateral surface is strongly reticulate; sub-central tubercule large and smooth. Three longitudinal ribs are present, the dorsal rib is strong and has a short bar that extends from its posterior end towards the median rib. The median rib is short.

The ventral rib is joined at the antero-ventral margin to a strongly calcified anterior marginal rib.

Variation: The size of the adults varies greatly within the same sample.

Remarks: This species was first recorded by Kaye (1965a) from the basal Upper Gault of Pinhay, Devon. This is the second record of this species which is limited in distribution to the marginal Upper Albian (M.inflatum Zone) of Devon. It differs from other species of this genus in being more strongly calcified, having stronger reticulation and stronger longitudinal ribs.

Stratigraphic conclusion: This species is very restricted in its spatial distribution, and is therefore of limited stratigraphic value.

Cythereis reticulata Jones & Hinde, 1890

(pl.17, figs.7,9)

1890 Cythereis ornatissima reticulata Jones & Hinde:24, pl.1, fig.68,  
pl.4, figs.9-12

1940 Cythereis reticulata Jones & Hinde; Triebel:192, pl.5, figs.51-56

1956 Cythereis reticulata Jones & Hinde; Deroo:1518, pl.5, figs.68,69,  
71,74

1963 Cythereis reticulata Jones & Hinde; Damotte & Grosdidier:pl.2,  
fig.6

1964a Cythereis hirsuta Damotte & Grosdidier; Gründel:pl.1, figs.6,7

1964c Cythereis reticulata Jones & Hinde; Kaye:67, pl.8, figs.16-19

1966 Cythereis reticulata reticulata Jones & Hinde; Gründel:36, pl.7,  
figs.1,2

1966 Cythereis reticulata duocostata Jones & Hinde; Gründel:36, pl.6,  
fig.25

1966 Cythereis hirsuta Damotte & Grosdidier; Gründel:35, pl.6, figs.16,20

1971b Cythereis reticulata Jones & Hinde; Damotte:64, pl.2, fig.10

1977 Cythereis reticulata Jones & Hinde; Charollais et. al.:pl.2, fig.10



- 1978 Cythereis reticulata Jones & Hinde; Van der Wiel: pl. 3, figs. 1-4;  
 pl. 4, fig. 1 (non pl. 4, figs. 2-13)
- 1978 Rehacythereis reticulata (Jones & Hinde); Neale: pl. 12, figs. 1, 2

**Diagnosis:** A large, inflated, species of Cythereis with three strongly developed longitudinal ribs and strong reticulation which covers the whole lateral surface.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 255 L.V. Female | 1.13m.m. | 0.67   | 0.37  |
| 256 R.V. Female | 1.08     | 0.58   | 0.31  |

**Description:** A large, inflated species with a straight dorsal margin. Three longitudinal frilly ribs are present on the lateral surface. These may be continuous or discontinuous. The discontinuous ribs are formed from a number of large frilly spikes extending in a lateral direction. The ventral rib is formed of seven spikes, the dorsal rib of four spikes and the median rib of four/five spikes. The spikes on the dorsal and ventral ribs may bifurcate terminally. The sub-central tubercle is well formed and bears a crown of spines. The lateral surface is covered by a coarse reticulation while the posterior marginal area is smooth. The anterior margin is broadly curved and the posterior margin is triangular. Antero-ventrally and postero-ventrally marginal denticulation is present, the postero-dorsal margin is concave. The hinge ear is distinct; eye tubercle prominent; hinge ear may also bear a number of spines which extend laterally. The males are much longer than the females. In the right valve the hinge ear is only poorly developed. Juveniles -1 have prominent, frilly, longitudinal ribs both dorsally and ventrally. These may be continuous or discontinuous. A strong reticulation is present covering most of the lateral surface. The subcentral tubercle is weakly developed and bears a number of spines.

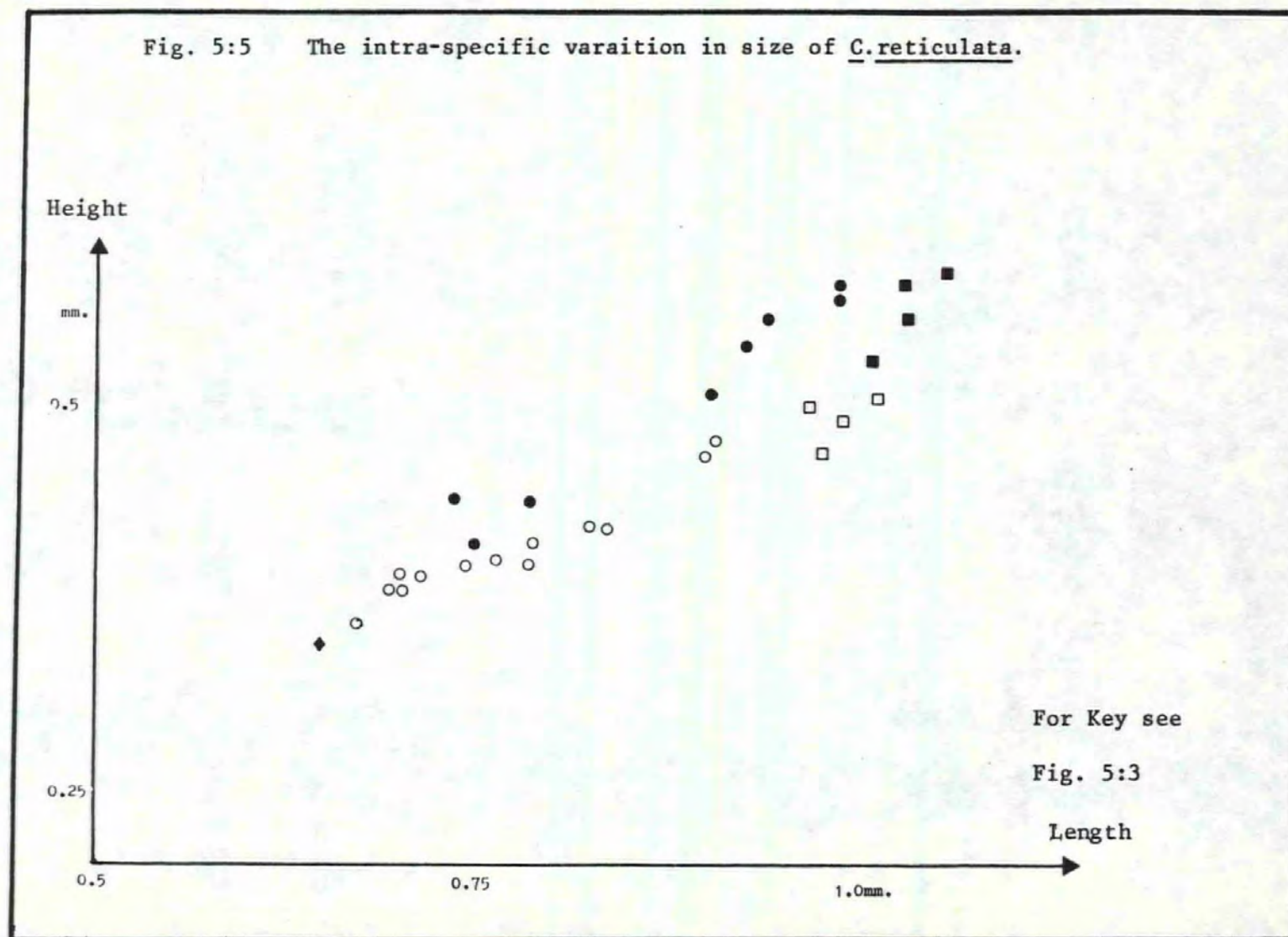
Variation: The dorsal and ventral ribs change from continuous frills to broken frills and finally to prominent spikes through the Middle Albian. The hinge ear also decreases in prominence through the same interval. Specimens show little variation in size (fig.5:5).

Remarks: This species has a confused taxonomic history. The confusion stems mainly from the original definition of Jones & Hinde (1890) in which they figured specimens of several species from various localities of Albian and Upper Cretaceous age but did not state from which locality each figured specimen originated. These specimens need examination before any firm conclusions can be reached; however, there is no trace of the type material.

Subsequent authors have followed the work of Triebel (1940) who figured specimens with three continuous frilly longitudinal ribs and a strong hinge ear in the left valve. Deroo (1956) included specimens of C.hirsuta and C.thoerenensis in his figured specimens of this species. Kaye (1964c) figured specimens with discontinuous frilly spines and not continuous frilly ribs. Gründel (1966) divided this species into two subspecies based on the different arrangement of ribs on the muscle node. This is not regarded as a valid reason for the definition of a subspecies. The specimens figured by Gründel as C.hirsuta are also included in this species as they have longitudinal ribs consisting of large frills and not of individual spines. C.reticulata differs from C.hirsuta in having frills and not spines. Damotte (1971b) also figured specimens with discontinuous frilly ribs. She recorded it ranging through the D.mammillatum and H.dentatus Zones of the Paris Basin. Neale (1978) figured specimens with continuous frilly longitudinal ribs from the Middle Albian of Speeton.

Van der Wiel (1978) figured many spinose specimens in his concept of this species. These specimens are very similar to the original figured specimens of C.hirsuta and must be related to this species. He also interpreted C.folkestonensis as evolving from C.reticulata.

Fig. 5:5 The intra-specific variation in size of C. reticulata.



For Key see  
Fig. 5:3

However, it has already been shown that C.hirsuta evolves from C.reticulata and that C.folkestonensis evolves from C.hirsuta.

Weaver (MS.) recorded a similar species that was rare in the Lower and Middle Cenomanian.

This species appears to have a diachronous occurrence across northwest Europe. In the Anglo-Paris Basin and in eastern England this species only occurs in the Middle Albian. It is absent from the Upper Albian although a similar form does occur in the Cenomanian. In Germany this species occurs throughout the Upper Albian. This species may be a colder water member of this genus.

Stratigraphic conclusion: This species occurs throughout the D.mammillatum and H.dentatus Zones of southern England. It last occurs in the D.niobe Subzone. It occurs throughout the Albian of Germany. It is of moderate, local, stratigraphic significance.

Cythereis rudispinata Chapman & Sherborn, 1893

(pl.22,figs.4,5,8)

1893 Cythereis rudispinata Chapman & Sherborn:348,pl.14,figs.6,7

non1940 Cythereis rudispinata Chapman & Sherborn;Triebel:200,pl.4,figs.

47-50

1964c Protocythere rudispinata (Chapman & Sherborn);Kaye:59,pl.5,

figs.9-11

1978 Protocythere (Mandocythere) rudispinata (Chapman & Sherborn);Van

der Wiel:pl.2,figs.5,6

1978 Cythereis rudispinata Chapman & Sherborn;Neale:pl.12,figs.7-12

Diagnosis: A species of the genus Cythereis with three longitudinal ribs formed of strong, flat topped, spines. The intercostal areas are smooth.

|                   | Length   | Height | Width |
|-------------------|----------|--------|-------|
| 257 L.V. Female   | 0.52m.m. | 0.35   |       |
| 258 R.V. Female   | 0.48     | 0.25   |       |
| 259 Dorsal Female | 0.57     | 0.29   | 0.18  |

Description: The valves of this species are relatively small and laterally compressed. The dorsal margin is straight with a weak hinge ear. The anterior margin is broadly curved; ventral margin straight; dorsal and ventral margins weakly converge posteriorly. Both the anterior and posterior margins bear denticules. On the lateral surface are three rows of stout, prominent, flat topped spines. Another row of spines runs along the ventral surface. The dorsal marginal rib consists of a double row of short stubby spines. The intercostal areas are smooth; hinge amphidont.

Remarks: Chapman & Sherborn (1890) originally described this species from the Gault Clay of Folkestone where they recorded it from Beds i to xi. Kaye (1964c) recorded this species from the Lower Gault and erected a lectotype. Kaye was correct in stating that the forms described by Triebel (1940) and by Deroo (1956) "differ fundamentally". Kaye also placed this species in the genus Protocythere while Neale (1978) recognised the amphidont nature of the hinge and placed this species in the genus Cythereis. Neale also remarked that this is one of the earliest species of Cythereis because the hinge elements are less differentiated than is general in the younger chalk forms. The anterior part of the median element is particularly poorly developed. He regarded this species as typical of the Middle Albian.

Stratigraphic conclusion: This species occurs very rarely in the Middle Albian and mainly in the A. intermedius Subzone of southern England. It is of limited stratigraphic value.

Cythereis thoerenensis Triebel, 1940

(pl.18,figs.3,5,6,9)

1940 Cythereis thoerenensis Triebel:195,pl.5,figs.57-59

?1956 Cythereis reticulata Jones & Hinde;Deroo:1518,pl.5,figs.75,78

non1962 Cythereis thoerenensis Triebel;Ellermann:408,figs.17-19

1964c Cythereis thoerenensis Triebel;Kaye:68,pl.7,fig.14(non figs.15,  
17)

?1966 Cythereis thoerenensis Triebel;Gründel:37,pl.6,fig.22

?1978 Cythereis reticulata Jones & Hinde;Van der Wiel:pl.4,fig.9

Diagnosis: A small species of Cythereis with smooth antero-lateral and postero-lateral areas and a prominent ventral rib.

|                   | Length   | Height | Width |
|-------------------|----------|--------|-------|
| 260 L.V. Male     | 0.91m.m. | 0.52   | 0.34  |
| 261 R.V. Female   | 0.80     | 0.45   | 0.34  |
| 262 Dorsal Female | 0.90     | 0.45   |       |
| 263 R.V. Male     | 0.82     | 0.46   |       |

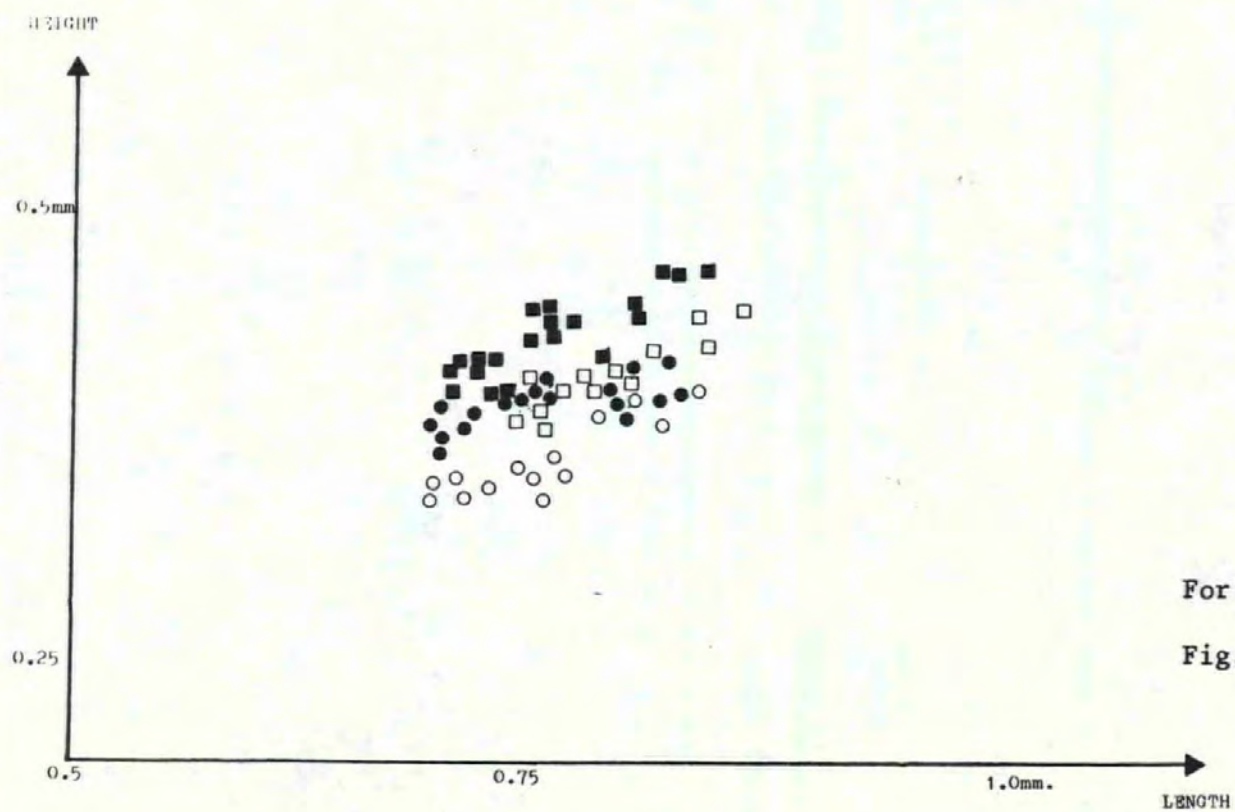
Description: A small, subrectangular species which has a straight dorsal margin; anterior margin broadly curved; posterior margin triangular. The mid-lateral surface is reticulate, the anterior and posterior areas of the lateral surface are smooth. The median rib is very reduced or absent, the dorsal rib is poorly developed and is formed from five or six small stubby spines. The ventral rib is distinct and consists of six flattened spines. The sub-central tubercle is well developed and is weakly ornamented or smooth. The hinge ear is absent but several short spines extend from beneath the eye tubercle. Marginal denticulation is stronger along the antero-ventral and postero-ventral margins.

Variation: This species exhibits only a small amount of variation in size (fig.5:6).

Remarks: Triebel (1940) originally described this species as



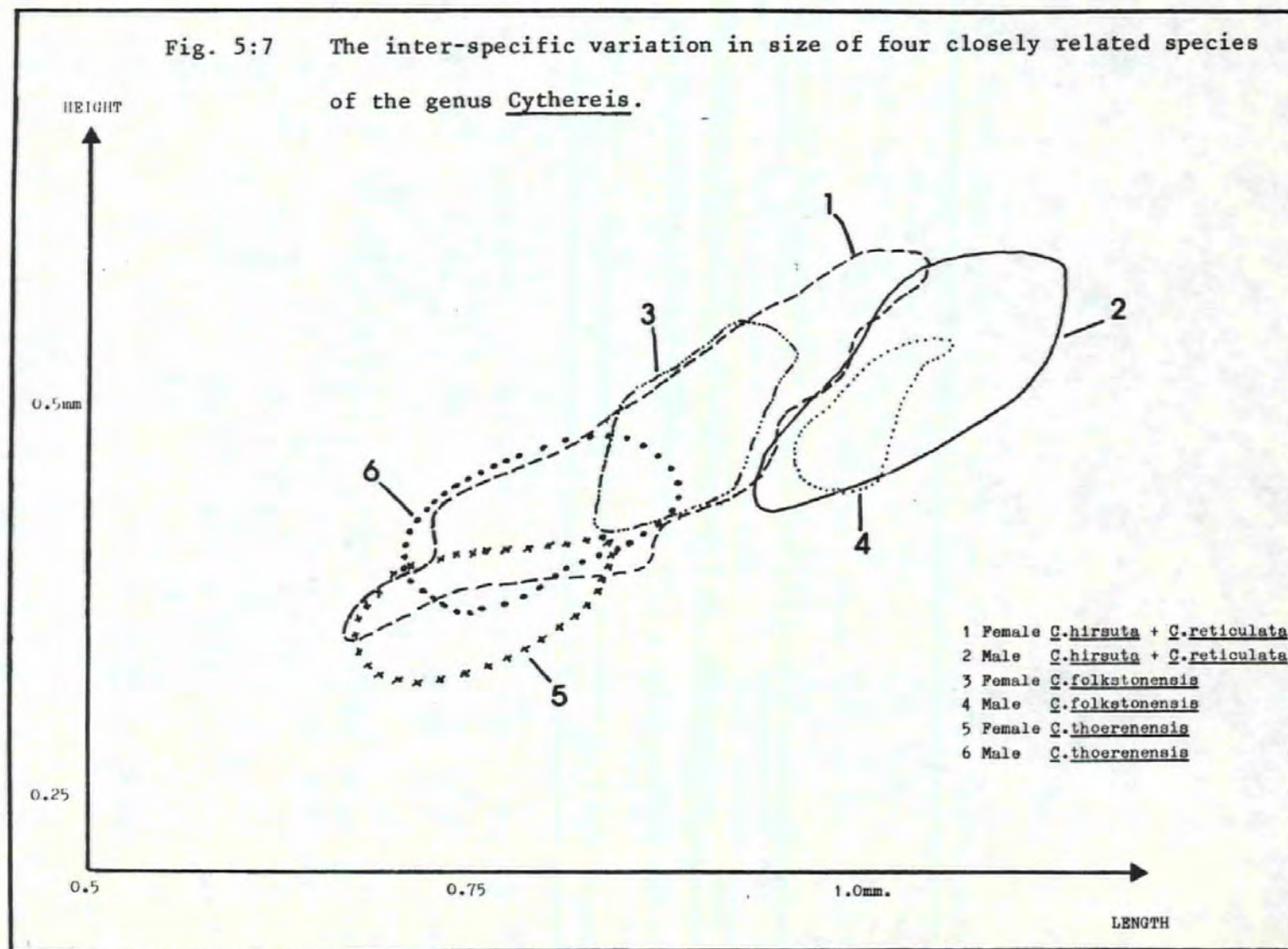
Fig. 5:6 The intra-specific variation in size of C. thoerenensis



For Key see

Fig. 5:3

Fig. 5:7 The inter-specific variation in size of four closely related species of the genus Cythereis.





having a reticulated surface with ribs separated into single spines. However, it is clear from his figured specimens that only the mid-lateral surface is strongly reticulate. The sub-central dorsal and median ribs appear reduced and the ventral longitudinal rib is well developed and consists of four or five strong frill like spikes. He also described this species evolving from C.reticulata which, since he included specimens of C.hirsuta in his concept of C.reticulata, is here regarded as correct.

Both Ellermann (1962) and Gründel (1966) figure specimens which resemble, but are not identical to, the figured specimens of Triebel. Those of Ellermann may more correctly be attributed to C.hirsuta. Gründel records this species from the Middle and Upper Albian of East Germany. This is very different to the range of this species in southern England where it only occurs in the S.dispar Zone.

This species is very closely associated with C.hirsuta in the S.dispar Zone and appears to have evolved from it, but differs in being smaller, lacking coarse spines, and having smooth antero-lateral and postero-lateral areas.

Weaver (MS.) recorded this species in the Cenomanian up to the level of the mid-Cenomanian non sequence.

Stratigraphic conclusion: This species occurs commonly in the S.dispar Zone of southern England. It ranges through into the Cenomanian and is of zonal significance.

Cythereis sp.A sp.nov.

(pl.20,figs.1,2,5)

Diagnosis: A small species of Cythereis with smooth intercostal areas and a prominent, smooth, sub-central tubercule.

|                      | Length   | Height | Width |
|----------------------|----------|--------|-------|
| 264 L.V. Female      | 0.67m.m. | 0.37   | 0.19  |
| 265 Dorsal Female C. | 0.63     |        | 0.28  |

Description: A small sub-rectangular species with slightly converging dorsal and ventral margins; dorsal margin straight; ventral margin slightly concave. A smooth hinge ear is present, ventrally to this a large eye tubercle is present. The anterior margin is broadly rounded and the posterior margin is sub-triangular. Five marginal denticles are present antero-ventrally with three/four denticles postero-ventrally. The sub-central tubercle is smooth, a small tubercle posteriorly of this appears to be the remnant of a median rib. The dorsal and ventral ribs are poorly developed and weakly crenulate. A short bar-like extension extends ventrally from the posterior end of the dorsal rib.

Remarks: This small species was only recorded sporadically in the S.dispar Zone where it was always recorded in association with C.hindei hindei. It is easily distinguished from the latter in having a lesser number of marginal denticles.

It appears similar to Cythereis nuda Kaye, 1964 and to a specimen of C.nuda Kaye figured by Neale, 1978. The lectotype of C.nuda originated from the 'Charing detritus' (Cenomanian). Specimens recorded from the Albian differ from that figured by Neale in having a completely smooth lateral surface. The relation of these forms is unclear. Neale recorded C.nuda from the Middle Albian to the Maastrichtian. C.nuda was not recorded from the Cenomanian by Weaver (MS.).

Stratigraphic conclusion: A rare species that was found sporadically in the S.dispar Zone of southern England. It is of limited stratigraphic value.

Genus Isocythereis Triebel, 1940

Type species: Isocythereis fissicostis Triebel, 1940

Isocythereis fissicostis Triebel, 1940

(pl.21,figs.3,4,6,7)

- 1940 Isocythereis fissicostis Triebel:209,pl.7,figs.71-74;pl.9,fig.108
- 1956 Isocythereis fissicostis Triebel;Mertens:207,pl.12,figs.79-81
- 1956 Isocythereis fissicostis Triebel;Deroo:1520
- 1962 Isocythereis fissicostis Triebel;Ellermann:406,figs.21a,b
- 1964b Isocythereis fissicostis gracilis Triebel;Gründel:853,pl.2,  
figs.3,4
- 1966 Isocythereis fissicostis fissicostis Triebel;Gründel:38,pl.8,  
fig.6
- 1966 Isocythereis fissicostis gracilis Triebel;Gründel:38,pl.7,figs.  
7-9
- 1978 Isocythereis fissicostis Triebel;Neale:pl.11,figs.2,3

Diagnosis: A small, strongly reticulate, species of Isocythereis with three prominent, sharp, longitudinal ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 211 L.V. Female | 0.43m.m. | 0.24   | 0.11  |
| 212 L.V. Male   | 0.48     | 0.24   | 0.09  |
| 213 R.V. Female | 0.41     | 0.19   | 0.09  |
| 214 R.V. Female | 0.47     | 0.24   |       |

Description: A small species with a straight dorsal margin which is partially obscured in lateral view. The anterior margin is broadly curved. A prominent anterior marginal frill extends from this margin in an anterior direction. A prominent dorsal rib extends around the dorsal margin. The lateral surface bears three sharp longitudinal ribs. The median rib extends from an elongate sub-central tubercule to join a bar like extension of the dorsal rib. The eye tubercule is small, below this a short rib extends towards the posterior, this projects in a dorsal direction. The lateral surface is strongly

reticulate. Marginal denticulation is present posteriorally. Males are longer than females.

Variation: Upper Albian specimens are smaller than Middle Albian specimens and have less well developed longitudinal ribs.

Remarks: This species was first recorded by Triebel (1940) from the N.minimus Zone of northwest Germany. Mertens (1956) also recorded it from the Lower and Middle Albian of northwest Germany while Deroo (1956) recorded it from the Middle Albian of the Paris Basin and Damotte (1971b) recorded it from the H.dentatus Zone of the Aube.

Gründel (1964b) subdivided this species into two subspecies based on the strength of ribbing and on the size of specimens. He showed that the size of specimens decreased in the Upper Albian and noted that intermediate specimens between the two subspecies occurred. This view is endorsed by the present study where the larger form was recorded from the Middle Albian and the smaller form from the Upper Albian. Smaller specimens than those recorded by Gründel were found in the S.dispar Zone.

Stratigraphic conclusion: In southern England this species first occurs in the D.niobe Subzone, last occurs at the top of the S.dispar Zone and is of moderate, local, stratigraphic significance. It is ubiquitously distributed across northwest Europe where it ranges throughout the Albian.

Isocythereis fortinodis Triebel, 1940

(pl.20,figs.10,11,13,14)

1940 Isocythereis fortinodis Triebel:211,pl.7,figs.75-77;pl.10,fig.

109

1956 Isocythereis fortinodis Triebel;Mertens:208,pl.11,fig.61

1964b Isocythereis fortinodis reticulata Triebel;Gründel:853,pl.2,  
figs.3,4

1966 Isocythereis fortinodis fortinodis Triebel;Gründel:39,pl.7,fig.5

1966 Isocythereis fortinodis reticulata Triebel;Gründel:39,pl.7,figs.

10,11

1971b Isocythereis fortinodis Triebel;Damotte:79,pl.4,fig.12

1978 Isocythereis fortinodis Triebel;Van der Wiel:pl.1,figs.18,19

1978 Isocythereis fortinodis Triebel;Neale:pl.10,fig.14;pl.11,fig.1

**Diagnosis:** A small species with a prominent sub-central tubercule and three sharply edged longitudinal ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 215 L.V. Female | 0.51m.m. | 0.25   | 0.14  |
| 216 R.V. Female | 0.49     | 0.25   | 0.13  |
| 217 R.V. Male   | 0.46     | 0.21   | 0.10  |
| 218 L.V. Female | 0.44     | 0.24   | 0.11  |

**Description:** A small species with a straight dorsal margin and strongly converging dorsal and ventral margins. The anterior margin is broadly rounded and posterior margin is triangular. The lateral surface is partially pitted with a large sub-central tubercule. Three sharp longitudinal ribs are present, the middle of which is very variable. The anterior margin bears an anterior marginal rib which extends anteriorally. The posterior margin bears a number of denticules. A small eye tubercule is present. Males are distinctly longer than females.

**Variation:** This is a variable species that changes greatly in size and ornamentation. The size decreases through the Upper Albian. The middle rib varies from being half the length of the valve to being absent. The amount of pitting varies from completely covering the lateral surface to a few pits surrounding the sub-central tubercule.

**Remarks:** This species was first described by Triebel (1940) from northwest Germany. It has also been described from East Germany and France.

Gründel subdivided this species into two subspecies. The larger of these, I.f.fortinodis, has a more rectangular outline, with better developed longitudinal ribs and no reticulation. The middle rib is not reduced and is connected to the muscle tubercule. He also noted that intermediate forms exist between the two subspecies. These subspecies can also be recognised by their size.

This species was not recorded from the Cenomanian of southern England by Weaver (MS.).

Stratigraphic conclusion: This species first occurs in the D.niobe Subzone of southern England; it has been recorded from the Middle and Upper Albian ubiquitously across northwest Europe. In southern England it last occurs in the topmost S.dispar Zone. It is of moderate stratigraphic significance.

Isocythereis sp.A. sp.nov.

(pl.21,fig.1)

Diagnosis: A large, subrectangular, species of Isocythereis with an irregularly pitted lateral surface.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 219 L.V. Female | 0.41m.m. | 0.27   | 0.14  |

Description: A large species with straight dorsal and ventral margins which slightly converge posteriorly. The dorsal margin is broadly rounded and the posterior margin bluntly triangular. A weak hinge ear is present antero-dorsally and a strong cardinal angle postero-dorsally. A few weak spines are present along the postero-ventral margin. The lateral surface bears three narrow longitudinal ribs, the median rib is joined at its posterior end to the dorsal rib. The sub-central tubercule and the eye tubercule are only weakly developed. The anterior marginal rib is narrow but well developed. The intercostal areas are covered by large pits which are irregular in

shape. The greatest height occurs at one fifth length.

Remarks: This species differs from I.fortinodis in being larger and lacking a well developed sub-central tubercule and an eye tubercule. It appears similar in outline to the larger Middle Albian specimens of I.fortinodis. It differs from I? magna Gründel, 1966 in lacking coarse reticulation and the quill like rib. This species was only recorded from the marginal facies of Seaton, Devon, where two specimens were found.

Stratigraphic conclusion: This is a very rare species with a very limited geographical distribution. It was only recorded from the M.inflatum Zone. It is of very limited stratigraphic value.

Isocythereis sp.B. sp.nov.

(pl.21,fig.2)

Diagnosis: A large, subrectangular, species of Isocythereis with narrow well defined ribs and smooth intercostal areas.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 220 L.V. Female | 0.41m.m. | 0.24   | 0.11  |

Description: A large, elongate, subrectangular species which has straight dorsal and ventral margins which weakly converge posteriorly. The anterior margin is broadly rounded; posterior margin bluntly rounded. A well developed hinge ear is present antero-dorsally and a strong cardinal angle postero-dorsally. The lateral surface bears three narrow longitudinal ribs. The median rib extends half the valve length and is joined posteriorly to the dorsal rib. The ventral rib is the weakest of the three. The sub-central tubercule and the eye tubercule are both weakly developed. The intercostal areas are smooth. The greatest height occurs at one fifth length.

Remarks: This species differs from others of this genus by having smooth intercostal areas. Only one specimen was recorded from the

M.inflatum Zone of Scaton, Devon.

Stratigraphic conclusion: A rare species that has a very limited distribution and is of limited stratigraphic value.

Genus Matronella Damotte, 1974

Type species: Cythereis matronae Damotte & Grosdidier, 1963

Matronella matronae (Damotte & Grosdidier, 1963)

(pl.20,figs.7,8)

?1940 Cythereis rudispinata Chapman & Sherborn;Triebel:200,pl.4,figs.

47-50

1956 Cythereis rudispinata Chapman & Sherborn;Deroo:1516

1963 Cythereis matronae Damotte & Grosdidier:57,pl.3,figs.71-f

1964c Cythereis corrigenda Kaye:62,pl.7,figs.6,9

?1966 Cythereis corrigenda Kaye;Gründel:33,pl.6,figs.7,8

1966 Cythereis matronae Damotte & Grosdidier;Gründel:36,pl.6,fig.11

1971b Cythereis matronae Damotte & Grosdidier;Damotte:64,pl.11,fig.9

1974 Matronella matronae (Damotte & Grosdidier);Damotte:182,pl.23,

figs.1-18;pl.24,figs.19-24

non1978 Matronella cf. matronae (Damotte & Grosdidier);Van der Wiel:pl.1

figs.11-15

1978 Matronella matronae (Damotte & Grosdidier);Neale:pl.17,figs.1-3

Diagnosis: A species of the genus Matronella which is externally very similar to species of Cythereis but has spines forming the dorsal and ventral ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 278 L.V. Female | 0.70m.m. | 0.44   | 0.23  |
| 279 L.V. Male   | 0.81     | 0.42   | 0.21  |

Description: In lateral view the anterior margin is broadly rounded, dorsal margin straight; ventral slightly concave; posterior



triangular. Postero-dorsal margin is slightly concave and meets the dorsal margin in a distinct cardinal angle. Five/six marginal denticules are present antero-ventrally and four/five postero-ventrally. The hinge ear is reduced. The eye tubercle is large and has a small frill extending from it along the dorsal margin on the anterior side of the anterior marginal rib. From the sub-central tubercle several spines project laterally while the median rib is reduced to two spines. The dorsal and median ribs are formed of a series of spines. The lateral surface is smooth.

Variation: The prominence of the spines is variable.

Remarks: This species was confused with C.rudispinata by Triebel, 1940. Damotte & Grosdidier (1963) noted this confusion and erected a new species. Unfortunately Kaye (1964c), unaware of this, also recognised the confusion and also erected a new species. Gründel (1966) recognised both C.matronae and C.corrigenda and appears to have interpreted them as chronospecies. He recorded C.corrigenda appearing in the Lower Albian to lower Middle Albian interval with C.matronae appearing in the upper Middle Albian to Lower Cenomanian interval.

Damotte (1974) erected C.matronae as the type species of the new genus Matronella. This genus was defined on the splitting of the two most dorsal muscle scars. This species was originally defined on the presence of spines on the smooth lateral surface. In this it differs from M? durispinata which possesses prominent frilly ribs. No intermediate specimens between the two have been observed.

Damotte recorded this species ranging from the H.dentatus to the M.inflatum Zone. Kaye recorded it from the H.dentatus Zone.

Stratigraphic conclusion: A rare species which occurs sporadically across northwest Europe and is most abundant in the Middle Albian. It is of limited stratigraphic value.

Matronella? durispinata (Gründel, 1964)

(pl.20,figs.6,9,12)

1964a Cythereis durispinata Gründel:745,pl.1,figs.8,9

1966 Cythereis durispinata Gründel;Gründel:34,pl.6,figs.9,10

1978 Matronella cf.matronae Damotte & Grosdidier;Van der Wiel:pl.1,  
figs.11-15

Diagnosis: A species with prominent frilly ribs which has been tentatively assigned to the genus Matronella.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 280 L.V. Female | 0.84m.m. | 0.48   | 0.25  |
| 281 R.V. Female | 0.81     | 0.45   | 0.24  |

Description: A sub-triangular species with a straight dorsal and a slightly concave ventral margin; valve strongly concave posteriorally. The dorsal margin is largely obscured by the prominent, frilly, dorsal rib. The sub-central tubercle bears a number of prominent spines crowning it. The median rib is formed of one or two spikes. The discontinuous ventral rib is formed of a series of frills. The anterior margin is broadly rounded; posterior margin triangular; postero-dorsal cardinal angle well developed. A strong anterior marginal frill extends along the antero-dorsal margin. It terminates at the eye tubercle which is of medium size. The hinge ear is poorly developed but has a distinct frill extending dorsally from it along the dorsal margin. Marginal denticulation is present along the antero-ventral and postero-ventral margins; in each case four or five pointed spikes are present. Two spines protrude from the posterior cardinal angle. The lateral surface is reticulate. Males are longer than females.

Variation: The prominence of the frills is variable.

Remarks: Gründel (1964b) originally described this species from East Germany. He recorded it ranging through the uppermost Albian and

Lower Cenomanian and described it with prominent 'comb like' ribs and reticulate intercostal areas. He also noted that the anterior margin bears an anterior marginal rib which runs from the eye tubercle to the mid-height of the valve, and, that below this rib five marginal denticules are present, and that a 'T' shaped bar is present on the muscle node which in dorsal view appears prominent. All these features are characteristic of specimens recorded in the Middle and Upper Albian of the Anglo-Paris Basin. These specimens have only previously been recognised as a separate species by Van der Wiel (1978) who referred them to M.matronae. They differ from the latter in bearing prominent frilly ribs and having reticulate intercostal areas. They occur in close association with specimens of C.lurmannae from which they differ in outline, prominence of their frilly ribs, and the presence of the 'T' shaped bar on the muscle node. More significantly they differ in anterior marginal denticulation which in C.lurmannae extends around the anterior margin, whereas in M? durispinata only five denticules are present antero-ventrally. In this it is similar to the type species of the genus Matronella. Unfortunately the muscle scars were not observed. No intermediate specimens were recorded between M.matronae and M? durispinata and they have thus been retained as separate species.

Van der Wiel recorded it throughout the M.inflatum Zone at Wissant.

Stratigraphic conclusion: This species first occurs in the D.niobe Subzone in the Anglo-Paris Basin where it ranges to the topmost Albian but does not occur in the Cenomanian. In Germany it first occurs in the topmost Albian and ranges into the Cenomanian. It is of moderate local stratigraphic significance.

Genus Planileberis Deroo, 1956

Type species: Cythere lepida Bosquet, 1854

Planileberis chathamensis Weaver MS.

(pl.19,figs.18,19)

1849 Cythere (Cythereis) cornuta (Roemer); Jones:21,pl.5,figs.13c,d  
(non pl.5,figs.13,a,b,e.)

1890 Cythereis ornatissima var.nuda Jones & Hinde:23,pl.2,figs.12,13

Diagnosis: A large species of Planileberis with relict first order reticulation on the lateral surface that consists of a large number of pits.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 282 L.V. Female | 0.79m.m. | 0.45   | 0.17  |
| 283 R.V. Female | 0.79     | 0.40   |       |

Description: A dorsally flattened species which is sub-triangular in outline. Marginal denticulation is present along the anterior and posterior margins. The hinge ear is small, two spikes extend from the anterior and posterior extremities of it in a dorsal direction. The sub-central tubercle is well developed and smooth. The median rib has almost vanished. The dorsal and ventral ribs are reduced to a series of small spines. At the posterior end of the anterior rib the 'bar like' rib is strongly developed. The lateral surface is covered with pits.

Variation: The Albian specimens of this species are larger than those described by Weaver (MS.) from the Cenomanian of southern England. Early specimens have coarser reticulation and are similar in appearance to contemporaneous specimens of C.lurmannae.

Remarks: Kaye (1964c) included figs.12 & 13 of Jones & Hinde (1890) in C.lurmannae. Weaver (MS.) included these specimens in his concept of this species.

Weaver recorded this species from the Lower and Middle Cenomanian up to the level of the mid-Cenomanian non sequence while in the present study this species was only recorded from the S.dispar Zone. These

early specimens are very similar to specimens of C.lurmannae from which it appears to have evolved. It differs from C.lurmannae in being more compressed in dorsal view, it also bears two prominent spines which project from the hinge ear.

Stratigraphic conclusion: This species first appears in the M.rostratum Subzone in southern England and ranges through to the mid-Cenomanian non sequence. It appears to be limited in occurrence to southern England where it is of moderate stratigraphic significance.

Planileberis sandersi Weaver MS.

(pl.19,figs.14,15)

Diagnosis: A small species of Planileberis with a densely pitted surface, a reduced dorsal rib, and a weakly developed, smooth, muscle node.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 471 L.V. Female | 0.56m.m. | 0.31   | 0.10  |
| 472 L.V. Female | 0.55     | 0.29   | 0.10  |

Description: The valves are small and very compressed dorsally. Dorsal and ventral margins are straight and converge strongly posteriorally. Two spikes extend in a dorsal direction from the hinge ear. The eye tubercle is of moderate size. The sub-central tubercle is smooth, the median rib is very reduced and consists of a small node. The dorsal and ventral ribs are very reduced, they consist of a few short spines. From their posterior ends two well developed 'bar like' extensions project towards the dorsal rib. The lateral surface is covered by a large number of pits.

Remarks: This species was first described by Weaver (MS.) from the Cenomanian of southern England. He recorded it from the Lower and Middle Cenomanian. In the Albian this species was recorded from the S.dispar Zone of southern England. It is smaller than specimens from

the Cenomanian.

Stratigraphic conclusion: This is a species that occurs sporadically in the S.dispar Zone of southern England and ranges through to the Middle Cenomanian. It appears to be limited in distribution to southern England where it is of moderate stratigraphic value.

Genus Platycythereis Triebel, 1940

Type species: Platycythereis gaultina (Jones, 1849)

Several of the Albian species of this genus have been misidentified by many previous authors. This problem has also involved the type species of the genus, Platycythereis gaultina (Jones, 1849). The confusion stems from the work of Triebel (1940). Triebel (1940) erected Cythereis excavata Chapman & Sherborn, 1893 as the type species of this genus but failed to recognise that this species is synonymous with P.gaultina. Platycythereis gaultina var. excavata (Chapman & Sherborn) was figured by Van Morkhoven as the type species of this genus. His specimens were from the Turonian of Germany and are closely related to P.chapmani Kaye, 1964. Moore et. al. (Treatise, 1961) also figured specimens closely related to Platycythereis chapmani Kaye, 1964. Thus, both these authors figured the wrong type species for this genus.

Platycythereis gaultina (Jones, 1849)

(pl.20,figs.16,17;pl.21,figs.8,12,13)

- 1849 Cythere (Cythereis) gaultina Jones:17,pl.2,figs.7a-c
- 1870 Cythere gaultina Jones;Jones:75,76
- 1890 Cythere gaultina Jones;Jones & Hinde:18,pl.1,figs.35,36
- ?1893 Cythere gaultina Jones;Chapman & Sherborn:346
- 1893 Cythereis gaultina var. excavata Chapman & Sherborn:348,pl.14,fig.8
- 1898 Cythere gaultina Jones;Chapman:336
- 1940 Platycythereis degenerata Triebel: 222,pl.8,figs.93-98.

- non1956 Platycythereis gaultina (Jones); Mertens: 209, pl. 11, figs. 59, 60
- 1956 Platycythereis degenerata Triebel; Mertens: 210, pl. 12, figs. 82-85
- 1956 Platycythereis degenerata Triebel; Deroo: 1520
- non1962 Platycythereis gaultina (Jones)?; Ellermann: 407
- 1962 Platycythereis degenerata Triebel; Ellermann: 406, fig. 20
- 1964c Platycythereis gaultina (Jones); Kaye: 68, pl. 8, fig. 9
- non1966 Platycythereis gaultina (Jones); Gründel: 40, pl. 7, fig. 18
- 1966 Platycythereis degenerata Triebel; Gründel: 39, pl. 7, fig. 17
- ?1971b Platycythereis degenerata Triebel; Damotte: 84, pl. 5, fig. 4
- 1978 Platycythereis gaultina (Jones); Van der Wiel: pl. 1, fig. 16
- non1978 Platycythereis gaultina (Jones); Van der Wiel: pl. 1, fig. 17
- non1978 Platycythereis gaultina (Jones); Neale: pl. 11, fig. 4

Diagnosis: A species of Platycythereis with no prominent frills and an anterior marginal rib.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 192 L.V. Female | 0.69m.m. | 0.36   |       |
| 193 R.V. Female | 0.65     | 0.35   | 0.20  |
| 194 L.V. Male   | 0.66     | 0.32   |       |
| 195 L.V. Female | 0.65     | 0.34   |       |
| 196 R.V. Female | 0.54     | 0.29   | 0.13  |

Description: A sub-rectangular species with straight dorsal and ventral margins which converge towards the posterior. The lateral surface is covered by a 'spongy' reticulation. A small tubercle occurs at two-fifths length on the lateral surface. Another small node occurs on the lateral surface at the postero-dorsal margin. An anterior marginal rib is inset from the anterior margin. Four large flattened spikes, which are bent antero-ventrally, extend from the mid part of the anterior margin to the junction with the ventral margin. Two large spikes extend from the posterior margin which is obtusely pointed. The anterior margin is curved and forms an obtuse angle at

its junction with the ventral margin. The males are longer than the females.

Variation: This species is smaller in the Upper Albian than it is in the Middle Albian. The main variation occurs within the H.dentatus Zone.

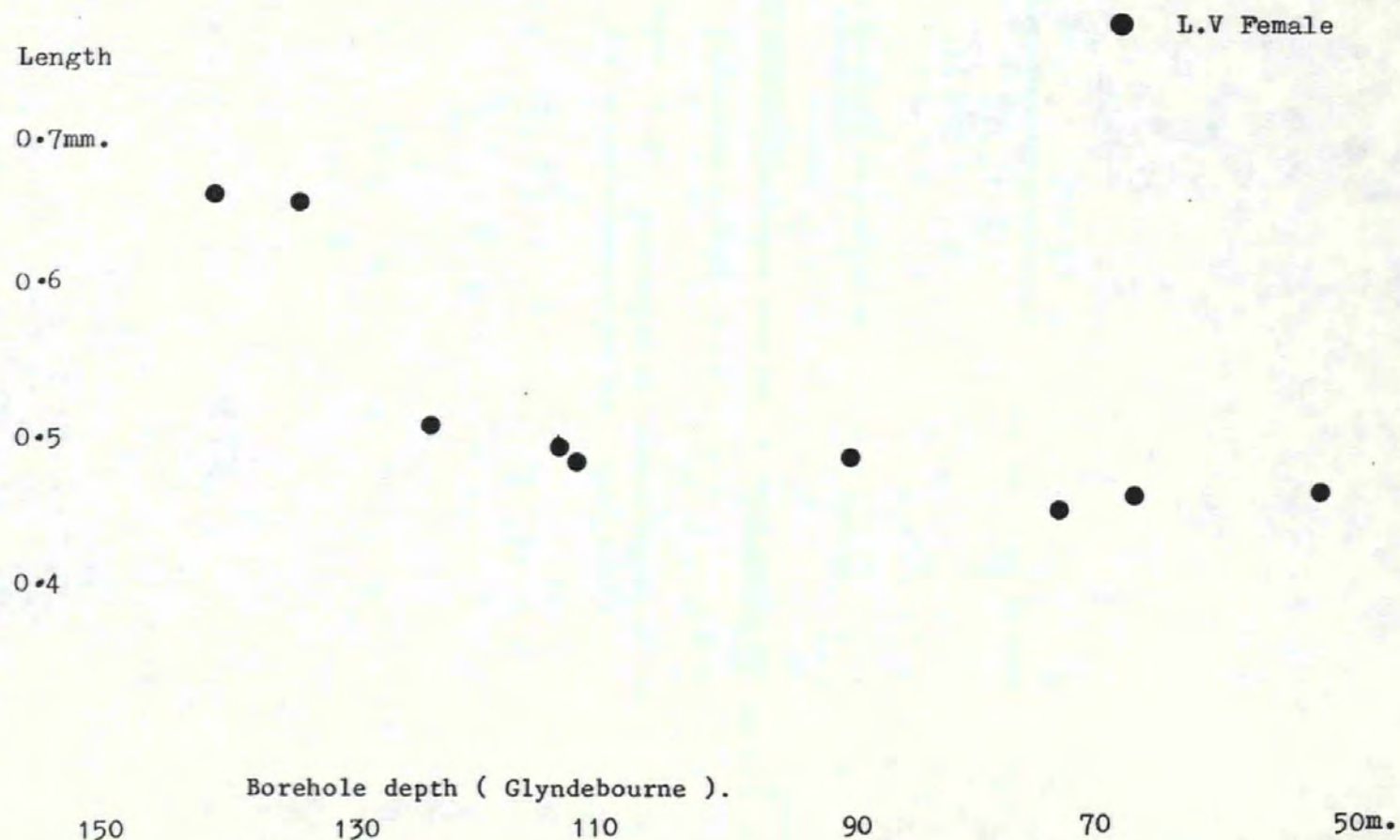
Remarks: This species has a very confused taxonomic history with both Chapman & Sherborn (1893) and Triebel (1940) describing junior synonyms. The former reference led Triebel (1940) to erect C.excavata as the type species of this genus while the name P.degenerata Triebel, 1940 has been followed by most subsequent authors. However, the original figures of Jones (1849) show clearly that this species lacks the antero-dorsal marginal frill that is present in the smaller Platycythereis sp.A.sp.nov. These two species were regarded as distinct by Triebel. However, Triebel did not recognise that P.degenerata Triebel, 1940 is a junior synonym of P.gaultina. The original specimens of P.gaultina were collected from the Gault Clay of Folkestone, and Kaye (1964c) recognising the true nature of this species, erected a lectotype (pl.8,fig.9.). P.gaultina differs from Platycythereis sp.A.sp.nov. in being larger and lacking ribs on the lateral surface. Van der Wiel (1978) figured specimens of both these species, regarding the smaller species as juvenile of P.gaultina and not as adults of a separate species.

This species has been recorded from the Middle and Upper Albian of England, Germany, and France. It has mainly been recorded from the Albian but has also been recorded from the Aptian by Triebel (1940).

Stratigraphic conclusion: This species occurs most abundantly in the Middle and Upper Albian. It occurs sporadically in the Albian of northwestern Europe. It has not been recorded in the Cenomanian but occurs in the S.dispar Zone. It is of moderate stratigraphic significance.



Fig. 5:8 The variation in size of Platycythereis sp.A.sp.nov. during the Middle and Upper Albian



Platycythereis chapmani Kaye, 1964

(pl.21,figs.14,16,17)

1898 Cythere gaultina excavata (Chapman & Sherborn);Chapman:336, text  
figs.2a,b

1898 Cythere subtuberculata Chapman:337,text figs.3a,b

1940 Platycythereis excavata (Chapman & Sherborn);Triebe1:215,pl.7,  
figs.78-80;pl.10,fig.110

1964c Platycythereis chapmani Kaye:69,pl.6,figs.16,18,20

Diagnosis: A large species of Platycythereis which has a frilly  
rib extending around the entire lateral margin in a lateral direction.

|                      | Length   | Height | Width |
|----------------------|----------|--------|-------|
| 203 R.V. Female      | 0.84m.m. | 0.40   | 0.18  |
| 204 L.V. Male        | 0.89     | 0.37   | 0.15  |
| 205 R.V. Male        | 0.74     | 0.35   | 0.15  |
| 190 Dorsal C. Female | 0.79     |        | 0.27  |
| 180 Dorsal C. Female | 0.47     |        | 0.20  |

Description: A sub-rectangular species which has straight and  
sub-parallel dorsal and ventral margins which converge weakly towards  
the posterior. A keel-like frill extends around the entire lateral  
margin; this extends in a lateral direction. The anterior end of the  
dorsal part of this frill is connected to the eye tubercule as is the  
antero-dorsal end of the dorsal frill. From the anterior margin four  
large flattened spikes which are bent antero-ventrally extend from the  
mid-point of the anterior margin along the antero-ventral margin. A  
short frill extends along the antero-dorsal margin on the anterior side  
of the main frill. It is joined to the main frill by a series of short  
bars. Several spines project from the posterior marginal frill. A  
strong 'spongy reticulation' covers the lateral surface. The lateral  
surface is weakly inflated, greatest width at two-fifths length.

Remarks: This species had a confused taxonomic history until Kaye

(1964c) defined a lectotype from the original material of Chapman (1898) which came from the Cambridge Greensand (Cenomanian) of Swaffam. It is very similar to P.laminata but differs in its arrangement of ribs. No intermediate specimens were recorded between the two species.

Weaver (MS.) recorded P.cf.P.chapmani from the lowest few metres of the Cenomanian in southern England. In this study P.chapmani was recorded very sporadically in the topmost S.dispar Zone. Specimens were more abundant in material collected from the top of the Gault Clay of Cambridgeshire. It has not been recorded from elsewhere in Europe.

Stratigraphic conclusion: This species has been recorded sporadically from the topmost Albian and lowest Cenomanian of southern England where it is of moderate stratigraphic significance.

#### Platycythereis laminata Triebel, 1940

(pl.21,figs.15,18,19.)

1940 Platycythereis laminata Triebel:217,pl.8,figs.88-90

1956 Platycythereis laminata Triebel;Deroo:1520

1964c Platycythereis laminata Triebel;Kaye:69,pl.6,fig.19

1966 Platycythereis laminata Triebel;Gründel:40,pl. 7,fig.19

1971b Platycythereis laminata Triebel;Damotte:85,pl.5,fig.6,text fig.

12A

1978 Platycythereis laminata Triebel;Neale:pl.11,fig.5

Diagnosis: A large species of Platycythereis with a prominent discontinuous frilly rib which extends around the margin of the lateral surface.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 206 L.V. Female | 0.79m.m. | 0.45   | 0.13  |
| 207 L.V. Male   | 0.84     | 0.44   | 0.14  |

Description: A sub-rectangular species with straight dorsal and

ventral margins that converge posteriorly. A discontinuous rib extends from the mid point of the anterior margin to the postero-ventral margin. Here it forms a right angle with the posterior marginal rib. A short rib one third the length of the anterior margin extends from the posterior marginal rib which it meets at right angles. A short dorsal marginal rib extends along the mid third of the dorsal margin. A marginal rib extends from the eye tubercle to the mid part of the anterior margin. Four dorsally directed, bent spikes, occur between the mid-point of the dorsal margin and the junction of the dorsal and ventral margins. The posterior margin is bluntly pointed. The lateral surface is weakly inflated and is covered by a coarse 'spongy' reticulation. Males are longer than females.

Remarks: This species was first recorded by Triebel (1940) from northwest Germany. It is morphologically similar to P.chapmani but differs in having discontinuous frilly ribs and not a continuous frilly rib. It has been recorded subsequently from East Germany and from the Anglo-Paris Basin. Triebel recorded it from the Lower Albian, Gründel (1966) from the lower Middle Albian, and Damotte (1971b) from the H.dentatus Zone. In the present study it was only recorded from the A.intermedius Subzone of southern England.

Stratigraphic conclusion: A rare species that only appears commonly in the H.dentatus Zone of the Anglo-Paris Basin while in southern England it is limited to the A.intermedius Subzone. It is of moderate local stratigraphic importance.

Platycythereis sp.A sp.nov.

(pl.21, figs.8,10,11; pl.22, figs.1,2,3,6,7)

1940 Platycythereis gaultina (Jones); Triebel:219, pl.7, figs.81-85

1956 Platycythereis gaultina (Jones); Mertens:209, pl.11, figs.59,60

- ?1962 Platycythereis gaultina (Jones); Ellermann: 406, fig. 20  
 1966 Platycythereis gaultina (Jones); Gründel: 40, pl. 7, fig. 18  
 1971b Platycythereis gaultina (Jones); Damotte: 85, pl. 5, fig. 5  
 1978 Platycythereis gaultina (Jones); Van der Wiel: pl. 1, fig. 17  
 1978 Platycythereis gaultina (Jones); Neale: pl. 11, fig. 4

Diagnosis: A small species of Platycythereis with an antero-dorsal frill that extends in a dorsal direction.

|                        | Length   | Height | Width |
|------------------------|----------|--------|-------|
| 198 L.V. Male          | 0.56m.m. | 0.29   | 0.13  |
| 199 L.V. Male          | 0.45     | 0.23   | 0.1   |
| 200 L.V. Female        | 0.47     | 0.25   | 0.1   |
| 201 L.V. Female        | 0.49     | 0.29   | 0.11  |
| 202 L.V. Female        | 0.45     | 0.29   | 0.09  |
| 183 L.V. Dorsal Female | 0.60     |        | 0.12  |
| 184 R.V. Female        | 0.54     | 0.27   |       |

Description: A small, sub-rectangular species with straight dorsal and ventral margins which converge posteriorly. The lateral surface is covered by a strong 'spongy' reticulation and possesses three tubercles, one sub-centrally, the others at the postero-dorsal and postero-ventral margins of the lateral surface. The anterior margin is curved and meets the ventral margin in an obtuse angle. Antero-dorsally a frill extends from the anterior margin in a dorsal direction, three frill like spikes extend from the postero-ventral margin. The posterior margin is obtusely pointed and two spines extend from it in a posterior direction. A prominent ridge runs around the anterior margin.

Variation: This species decreases in size during the Middle and Upper Albian (fig. 5:8).

Remarks: This species was originally confused by Triebel (1940) who assigned it to P. gaultina (Jones, 1849). It differs from P. gaultina in being smaller and possessing a distinct marginal frill antero-dorsally.

Many authors have subsequently followed Triebel. Only Kaye (1964c) figured a specimen of P.gaultina (pl.8,fig.9) sensu stricta. However, Kaye incorrectly placed P.gaultina Triebel, 1940 in the synonymy of P.gaultina s.s., and thus he also failed to recognise the difference between these two species.

Owing to the taxonomic confusion of this species it is difficult to assess its distribution across northwest Europe. However, it has been recorded extensively from the Middle and Upper Albian and while Kaye (1964c) has recorded it from the Lower Albian of Speeton, Weaver (MS.) has recorded P.cf.P.gaultina from the lowest few metres of the Cenomanian of southern England. This latter form is here regarded as synonymous with Platycythereis sp.A. sp.nov.

Stratigraphic conclusion: This species has been recorded from throughout the Albian and from the lowest Lower Cenomanian. In southern England it first occurs in abundance in the D.niobe Subzone.

Genus Alatacythere Murray & Hussey, 1942

Type species: Cythereis (Pterygocythereis?) alexanderi Howe & Law,  
1936 (non Morrow, 1934)

Alatacythere robusta langi (Jones & Hinde, 1890)  
(pl.30,fig.11)

1965c Alatacythere robusta langi (Jones & Hinde); Kaye:241,pl.10,figs.  
1-4

Diagnosis: A small species of Alatacythere which has a poorly pronounced alae and a short rib parallel to, and slightly inset from, the dorsal margin.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 442 R.V. Female | 0.81m.m. | 0.49   | 0.29  |

Description: A sub-rectangular species with straight dorsal and ventral margins which converge slightly posteriorally. The anterior

margin is broadly rounded; posterior margin bluntly triangular with a distinct postero-dorsal cardinal angle. Marginal denticulation is present antero-ventrally and postero-ventrally. A strong antero-ventral marginal rib is present, this extends round the antero-ventral margin and continues along the ventral margin of the alae. A short, strong, curved rib is present slightly inset from the dorsal margin at two-thirds length. The lateral surface is smooth and inflated mid-latero-ventrally; this inflation is produced into a postero-ventrally directed alae. The short dorsal marginal rib and the alae both obscure parts of their respective margins. In ventral view the alae appears triangular with several stubby spines extending from its posterior margin; these are connected to several sinuous striations which extend diagonally across this margin from the antero-ventral margin. The marginal rib of the alae appears pitted.

Remarks: This subspecies was first described by Kaye (1965c) from the Gault Clay of Pinhay, Devon (M.inflatum Zone). This species differs from Alatacythere sp.A. sp.nov. in possessing a prominent, short, dorsal marginal rib while lacking a prominent eye tubercule and prominent antero-ventral marginal denticulation. In the present study it was recorded from the marginal Gault Clay of Seaton, Devon. This species stratigraphically precedes Alatacythere sp.A. sp.nov. and appears to be limited in distribution to the marginal facies of the west country.

Stratigraphic conclusion: This species is limited in distribution to the M.inflatum Zone of Devon. It is of limited stratigraphic value.

Alatacythere sp.A sp.nov.

(pl.30,figs.10,12)

?1893 Cytheropteron alatum cornuta Jones & Hinde;Chapman & Sherborn:

347

1964c Alatacythere robusta (non Jones & Hinde);Kaye:57,pl.2,figs.7-16,18

1965c Alatacythere robusta robusta (non Jones & Hinde);Kaye:240,pl.10,  
figs.9,10

Diagnosis: A smooth sub-species of Alatacythere with a long, pointed, postero-ventrally directed alae.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 440 L.V. Male   | 1.13m.m. | 0.55   | 0.41  |
| 441 R.V. Female | 0.95     | 0.52   | 0.45  |

Description: A large sub-rectangular species with a straight dorsal margin; anterior margin broadly rounded; ventral margin straight; posterior margin triangular. Five or six strong spines are present along the posterior margin; denticulation along the anterior margin is weaker. A weak antero-marginal rib extends from the weak eye tubercle around the anterior margin and is extended to join the rib running along the ventral margin of the alae; this rib is much stronger antero-ventrally and ventrally. The lateral surface is smooth and is strongly inflated ventro-laterally, this inflation is formed into a postero-ventrally directed alae. A small depression is present posteriorly of the eye tubercle. A short, curved, longitudinal rib is present at two-thirds length and is slightly inset from the dorsal margin. The alae overhangs the ventral margin. The prominent alae appears triangular in ventral view; the posterior edge of the alae is slightly concave. A striation runs from the ventral margin at two fifths length diagonally across the ventral surface. The hinge is amphidont, the posterior tooth in the right valve is elongate and divided.

Remarks: This species has a confused taxonomic history which was partially resolved by Kaye (1965c). However, he further confused it by taking the name of a predominantly Upper Cretaceous species, Cytheropteron alatum robustum Jones & Hinde, 1890 to describe the Albian forms. Only the unfigured specimen of Chapman & Sherborn (1893) can be regarded as conspecific with the specimens recorded in the present study. Unfortunately this specimen is not available for examination, and therefore, to avoid further confusion this species has been assigned to



Alatacythere sp.A. sp.nov.

Weaver (MS.) recorded this species as rare throughout the Cenomanian of southern England. However, he placed it in the subgenus Pterygocythereis (Pterygocythere).

Stratigraphic conclusion: This species was recorded from the S.dispar Zone of southern England. It only occurs rarely and is of moderate stratigraphic significance.

Genus Protocythere Triebel, 1938

Type species: Cytherina triplicata Roemer, 1841

Protocythere derooi Oertli, 1958

(pl.22,fig.10)

1958 Protocythere derooi Oertli:1509,pl.6,figs.129-143

1965b Protocythere derooi Oertli;Kaye:44,pl.6,fig.6

1965 Protocythere derooi Oertli;Kaye & Barker:383,pl.50,figs.6,8,9,11

1971b Protocythere (Protocythere) derooi Oertli;Damotte:89,pl.5,fig.16

Diagnosis: A small, compressed, species of Protocythere which is sub-rectangular in outline and has a smooth lateral surface.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 317 R.V. Female | 0.60m.m. | 0.34   | 0.34  |

Description: A small, poorly inflated species which has a strong anterior hinge ear, straight dorsal margin and poorly developed posterior hinge node. The anterior margin is broadly rounded and continues into the strongly curved ventral margin which meets the blunt posterior extremity. The postero-dorsal margin is short and straight. Three prominent, smooth, longitudinal ribs of similar length are present on the lateral surface. These are evenly inflated. The posterior ends of the dorsal and ventral ribs are curved towards the posterior end of the median rib. The lateral surface is smooth.

Remarks: This species was first described by Oertli (1958) from

the Upper Albian and Lower Albian of Apt, France. Kaye (1965b) and Kaye & Barker (1965) recorded this species from the Upper Aptian and Middle Albian of England. Damotte (1971b) recorded it from the Middle Albian of the Paris Basin.

Stratigraphic conclusion: This species appears very rarely in the A.intermedius Subzone of southern England. It ranges from the Upper Aptian to the Middle Albian in the Anglo-Paris Basin where it is of limited stratigraphic value.

Protocythere lineata (Chapman & Sherborn, 1893)

(pl.22,figs.12-18;pl.23,figs.1-3)

1893 Cythereis triplicata var.lineata Chapman & Sherborn:348,pl.14,  
fig.5

1938a Protocythere jonesi Triebel:186,pl.1,figs.8-10

1963 Protocythere albae Damotte & Grosdidier:54,pl.1,figs.3a-h

1964c Protocythere consobrina Triebel;Kaye:57,pl.5,figs.17-19

1964c Protocythere lineata (Chapman & Sherborn);Kaye:58,pl.5,figs.1-3,  
5,7,8 (?figs.4,6)

1966 Protocythere albae Damotte & Grosdidier;Gründel:26,pl.4,figs.9-10,  
text figs.6a,b

1971b Protocythere (Protocythere) albae Damotte & Grosdidier;Damotte:  
89,pl.5,fig.15

1977 Protocythere albae Damotte & Grosdidier;Charollais et. al.:pl.2,  
figs.8,9

1978 Protocythere (Protocythere) albae Damotte & Grosdidier:Van der  
Wiel:pl.2,fig.1

Diagnosis: A large, inflated, sub-triangular, species of Protocythere with three inflated longitudinal ribs, valves strongly dimorphic.

|                    | Length   | Height | Width |
|--------------------|----------|--------|-------|
| 318 R.V. Male      | 1.08m.m. | 0.57   |       |
| 319 L.V. Male      | 1.03     | 0.59   |       |
| 320 L.V. Female    | 0.82     | 0.52   |       |
| 321a R.V. Female   | 0.79     | 0.44   |       |
| 321b L.V. Female   | 0.80     | 0.52   |       |
| 321c R.V. Male     | 1.11     | 0.56   |       |
| 321d Dorsal Male C | 1.11     |        | 0.56  |
| 321e L.V. Female   | 0.84     |        | 0.4   |
| 321f R.V. Male     | 0.93     | 0.48   |       |

Description: A large, inflated species which is sub-triangular in outline; hinge ear in right valve prominent, globose. The dorsal margin is straight; anterior margin is broadly rounded and continues into the strongly curved ventral margin; postero-dorsal margin is straight, short, and meets the dorsal margin at the cardinal angle. The right valve has a prominent pointed posterior with a notch on its dorsal side. At the postero-dorsal margin a gently sloping shelf is present. The lateral surface has three longitudinal, inflated ribs. The dorsal rib extends half the valve length; it is smooth, inflated and dorsally convex. The median rib is inflated; ventral rib is inflated and runs parallel to the ventral margin. From the ventral margin of this rib the lateral surface is steeply inclined towards the ventral valve margin, this surface bears a number of longitudinal striations. In the right valve the median rib is straight and more inflated in the area of the muscle scars. The three ribs are similar in length. The lateral surface is generally pitted.

Sexual dimorphism is strong with the males both longer and higher than females.

Variation: Middle Albian specimens of this species from southern England are very similar to the holotype. In the Upper Albian this species becomes smaller and less inflated. The ribs become more angular

and the intercostal areas more depressed. The anterior end of the median rib becomes relatively more inflated. Surface pitting is very variable.

Remarks: This species has a confused taxonomic history. Chapman & Sherborn (1893) originally figured this species from the Gault Clay of Folkestone. They described it from Beds i to xi. The figured specimen, which Kaye (1964c) later erected as lectotype, was collected from Bed i (A.intermedius Subzone). He did this without the knowledge that Damottee & Grosdidier (1963) had described this as a new species from the D.mammillatum Zone of the Aube. However, this species is synonymous with the figured specimen of Chapman & Sherborn (1893).

Triebel (1938a) also described a new species, P.jonesi, which was collected from the Lower Gault at Folkestone. This species, according to Triebel, differs from P.lineata in having reticulate intercostal areas. Kaye regarded this species as synonymous with P.lineata. This reticulation was not observed in any of the topotypic material examined from the Lower Gault at Folkestone but was recorded in specimens of P.striata from the topmost Albian.

Kaye (1964c) recorded a new species, P.consobrina, from the Middle and Upper Albian of the southern North Sea Basin. This is regarded as a non ornamented form of P.lineata.

In southern England P.lineata was recorded from the Middle and lower Upper Albian and is regarded as a chronospecies of P.striata. It gradually evolves into the latter which first appears in the C. auritus Subzone in southern England. In East Germany Gründel recorded this transition between the two species in the Middle Albian. This highly diachronous transition between P.lineata and P.striata Gründel, 1966 may be the result of environmental control of these species. This problem is further discussed in the concluding chapters.

Stratigraphic conclusion: This species has been recorded from

the Lower, Middle and lower Upper Albian. In southern England it occurs abundantly in the Middle and lower Upper Albian and is of moderate, local, stratigraphic importance.

Protocythere siddiqui Weaver MS.

(pl.22, figs.9,11.)

1971 Protocythere aff. albae Damotte & Grosdidier; Keen & Siddiqui:

64, pl.2, figs.4,8

Diagnosis: A small species of Protocythere which is elongated and has a longitudinal swelling on the ventral surface of the left valve.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 322 L.V. Female | 0.77m.m. | 0.48   | 0.27  |
| 323 L.V. Male   | 0.89     | 0.54   | 0.33  |

Description: A smooth species which has a rounded hinge ear. Dorsal margin concave; dorsal and ventral margins broadly curved; posterior margin pointed. The postero-dorsal margin is short and straight; postero-dorsal cardinal angle rounded. The lateral surface bears three, smooth, longitudinal ribs. The dorsal and ventral ribs are poorly developed; median rib straight and more inflated anteriorly. Intercostal areas are poorly depressed. Sexual dimorphism strong; males are much longer than females.

Remarks: This species was first named by Weaver (MS.) having previously been figured by Keen & Siddiqui (1971) from the Lower Cenomanian Greensand of Northern Ireland. Weaver only recorded it from the topmost Lower Cenomanian of Southerham, Sussex. In the present study it was only recorded from the marginal Upper Greensand (S.dispar Zone) of Cauville, France. It appears to occur in association with marginal, sandy, facies.

Stratigraphic conclusion: This species has only been recorded from the Lower Cenomanian of the British Isles and from the topmost Albian of northwestern France. It is of limited stratigraphic value.

Protocythere striata (Gründel, 1966)

(pl.24,figs.1-8,10.)

71849 Cythere (Cythereis) triplicata (Roemer); Jones:18,pl.3,figs.9a,b,  
e,f (non figs.9c,c',d,d')

71890 Cythereis triplicata (Roemer); Jones & Hinde:19,pl.1,figs.56,59,  
61 (non figs.57,58,60)

71898 Cythereis triplicata var. lineata Chapman & Sherborn; Chapman:338

71956 Protocythere jonesi Triebel; Deroo:1514

1966 Protocythere lineata striata Gründel:26,pl.4,figs.7-8,14,15

Diagnosis: A species of the genus Protocythere with three prominent, pointed ribs, the dorsal of which is strongly arched.

|                    | Length   | Height | Width |
|--------------------|----------|--------|-------|
| 324 L.V. Female    | 0.84m.m. | 0.52   |       |
| 325 R.V. Female    | 0.95     | 0.54   |       |
| 326 R.V. Female    | 0.70     | 0.41   |       |
| 327 L.V. Male      | 0.87     | 0.57   |       |
| 328 L.V. Male      | 0.64     | 0.40   | 0.23  |
| 329a R.V. Female   | 0.65     | 0.41   | 0.23  |
| 329b L.V. Female   | 0.79     | 0.53   |       |
| 329c Dorsal Male   | 0.80     |        | 0.46  |
| 329d Dorsal Female | 0.79     |        | 0.42  |

Description: This sub-triangular species has a straight dorsal margin and broadly curved anterior margin. The ventral margin is sinuous, being slightly concave at its mid-length. It curves towards the posterior extremity. The postero-dorsal margin is short and

straight. The hinge ear is prominent. The lateral surface bears three sharply defined longitudinal ribs. The dorsal rib is strongly arched and partly obscures the dorsal margin. The median rib is straight and is more inflated at its anterior end in the region of the muscle scars. The dorsal rib has a sharp edge and is dorsally concave. All three ribs are of similar length, the dorsal and ventral ribs curve posteriorly towards the median rib. The lateral surface is smooth and slopes towards the dorsal margin. The ventral surface is steeply inclined and bears a number of longitudinal striations. Males are much longer than females.

Remarks: This species has a confused taxonomic history which stems mainly from the original description of P. lineata Chapman, 1898. Kaye (1964c) partially resolved this problem by erecting a lectotype (the original figured specimen) which unfortunately is a juvenile specimen. Various specimens of this species have been included in other species by early authors including Chapman & Sherborn, 1893. These records are very confused and led Gründel (1966) to describe it as a new species from the Albian of East Germany. His diagnosis of this species recorded it with a smooth lateral surface. Since many of the specimens from southern England are weakly reticulate the degree of reticulation is not regarded as a specific characteristic.

Gründel recorded this species from the Middle and Upper Albian. In southern England it was only recorded from the M. inflatum and S. dispar Zones. Gründel also regarded it as a chronospecies of P. lineata.

Weaver (MS.) recorded this species in the Lower and lower Middle Cenomanian of southern England.

Stratigraphic conclusion: A common species which ranges from the lower part of the C. auritus Subzone in southern England through into the Cenomanian. This species has a highly diachronous first appearance across northwest Europe and can only be regarded as of moderate, local, stratigraphic significance.

Protocythere sp.A. sp.nov.

(pl.23, figs.17,18)

Diagnosis: A strongly pitted species of Protocythere.

|                 | Length  | Height |
|-----------------|---------|--------|
| 473 L.V. Male   | 1.1m.m. | 0.65   |
| 474 L.V. Female | 1.0     | 0.56   |

Remarks: Two specimens of this species were recorded from the basal clay of borehole 49/19-1. These specimens may indicate a Lower Albian or Aptian age for this clay (Kemper, 1971).

Stratigraphic conclusion: A rare species which has only been recorded from the Lower Cretaceous clays of borehole 49/19-1. It is of limited stratigraphic significance.

Genus Batavocythere Kemper, 1971

Type species: Batavocythere hiltermanni Kemper, 1971

Batavocythere gaultina (Kaye, 1963)

(pl.23, figs.10,13.)

1963d Protocythere gaultina Kaye:231, pl.19, figs.3-5

1965b Protocythere gaultina Kaye;Kaye:44, pl.6, fig.6

1966 Protocythere gaultina Kaye;Gründel:26, pl.4, fig.16

1971 Batavocythere gaultina (Kaye);Kemper:407, pl.3, fig.1

1978 Batavocythere gaultina (Kaye);Neale:pl.3, figs.10-13

Diagnosis: A small, sub-rectangular, strongly reticulate, species of Batavocythere with five frill-like longitudinal ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 330 L.V. Female | 0.56m.m. | 0.32   | 0.13  |

Description: A heavily ornamented, sub-rectangular species with a straight dorsal margin which is obscured by the dorsal rib in lateral view. The hinge ear is distinct; anterior margin broadly rounded with marginal denticulation antero-ventrally. The ventral margin is gently



convex curving more strongly postero-ventrally to join the posterior extremity. It is partially obscured by the longitudinal rib on the lateral surface. The postero-dorsal margin is short and straight. The lateral surface bears three longitudinal ribs and the ventral surface one. A dorsal marginal rib runs parallel to the dorsal margin. The anterior rib is straight and joins the anterior marginal rib posteriorally. The median and ventral ribs are gently curved, the median rib is slightly inflated in the area of the muscle scars. All the ribs are frill-like and are all intimately connected with the strong reticulation which covers the entire lateral surface. Males are longer than females.

Remarks: This very distinctive species was originally described by Kaye (1963d) from the Middle Albian of West Heslerton, Yorkshire. Kaye (1965b) also recorded this species from the Aptian of the Isle of Wight and from the Albian of the Paris Basin. He noted that the Aptian and Albian specimens are morphologically identical.

Gründel (1966) recorded it from the basal Middle Albian of East Germany. Kemper (1971) postulated a phylogenetic sequence from this and its closely related species. He showed that this genus evolved in the basal Upper Aptian and that Batavocythere gaultina first appeared in the Upper Aptian and ranged through into the basal Middle Albian.

Stratigraphic conclusion: This species appears sporadically in the Lower and Middle Albian of northwest Europe and is of limited stratigraphic significance.

Genus Mandocythere Gründel, 1964

Type species: Cythere harrisiana Jones, 1870

Mandocythere ex.gr.M.harrisiana (Jones, 1870)

(pl.25,figs.1-17)

1849 Cythere (Cythereis) interrupta (Bosquet); Jones:16,pl.2,figs.6a-g

- 1849 Cythere (Cythereis) quadrilaterata (Roemer); Jones:19, pl.4, figs.  
10h,i
- 1870 Cythere harrisiana Jones:75,76
- 1890 Cythere harrisiana Jones; Jones & Hinde:16, pl.1, figs.47-52
- 1890 Cythere harrisiana reticosa Jones & Hinde:18, pl.1, fig.64
- 1890 Cythere harrisiana setosa Jones & Hinde:17, pl.1, figs.43-45
- 1890 Cythereis auriculata (Cornuel); Jones & Hinde:19, pl.1, figs.53-55
- 1893 Cythere harrisiana Jones; Chapman & Sherborn:346
- 1893 Cythere harrisiana reticosa Jones & Hinde; Chapman & Sherborn:  
348, pl.14, fig.4
- 1893 Cythere konickiana (Bosquet); Chapman & Sherborn:348, pl.14, fig.2
- 1938a Protocythere auriculata (Cornuel); Triebel:195, pl.2, figs.27-31
- 1954 Protocythere auriculata (Cornuel); Stchépinsky:494, pl.22, fig.9
- 1956 Protocythere triebeli Deroo:1515
- 1961 Protocythere aptensis inflata Moullade:216, pl.1, figs.13,14
- 1963d Veenia triebeli (Deroo); Kaye:233, pl.18, figs.10,11
- 1963d Homocythere reticulata Kaye:234, pl.18, figs.8,9
- 1966 Mandocythere (Mandocythere) harrisiana harrisiana (Jones); Gründel:  
29, pl.5, figs.5,6,9,10; pl.10,  
fig.5
- 1966 Mandocythere (Mandocythere) harrisiana inflata (Moullade); Gründel:  
30, pl.5, figs.7,8
- 1966 Mandocythere reticulata Kaye; Gründel:40, pl.7, fig.23
- 1968 Protocythere (Mandocythere) harrisiana harrisiana (Jones); Damotte:  
389, pl.17, figs.12a-c
- 1971b Protocythere (Mandocythere) harrisiana harrisiana (Jones); Damotte:  
90, pl.5, fig.20
- 1977 Homocythere harrisiana harrisiana (Jones & Hinde); Charrolais et.  
al.: pl.2, figs.6,7
- 1978 Protocythere (Mandocythere) harrisiana harrisiana (Jones); Van der  
Wiel: pl.2, figs.1-4

Diagnosis: A species of Mandocythere with three rounded longitudinal ribs and a well developed, rounded, hinge ear.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 286 | L.V. Female      | 0.89m.m. | 0.60   |       |
| 287 | L.V. Male        | 0.95     | 0.58   | 0.34  |
| 288 | L.V. Male        | 0.93     | 0.62   |       |
| 289 | L.V. Female      | 0.87     | 0.56   |       |
| 290 | R.V. Male        | 1.08     |        | 0.38  |
| 291 | Carapace, Male   | 1.0      |        |       |
| 292 | L.V. Male        | 1.0      |        | 0.22  |
| 293 | L.V. Female      | 0.8      |        | 0.23  |
| 294 | L.V. -1          | 0.60     |        | 0.39  |
| 295 | Carapace, Female | 0.8      |        | 0.50  |
| 296 | L.V. Male        | 0.91     | 0.46   | 0.29  |
| 297 | R.V. Female      | 0.77     | 0.42   | 0.26  |
| 298 | L.V. Female      | 0.79     | 0.52   | 0.30  |
| 300 | L.V. Female      | 0.75     | 0.47   | 0.19  |
| 301 | L.V. Male        | 0.84     | 0.57   | 0.26  |
| 302 | L.V. Juv.        | 0.95     | 0.53   |       |

Description: A sub-rectangular species which is strongly calcified and distinctly inflated. The dorsal margin is straight with a prominent rounded hinge ear; ventral margin is weakly convex, straight in male valves; anterior margin rounded; posterior margin bluntly rounded with a prominent postero-dorsal cardinal angle. At the posterior end of the right valve a strong, posteriorly directed spine is often present. Marginal denticulation is present antero-ventrally, several small spines may protrude from the postero-ventral margin. The dorsal margin is strengthened by a low marginal rib. The lateral surface bears three smooth or weakly corrugated

longitudinal ribs, the intercostal areas are smooth. The dorsal margin is curved and obscures the dorsal margin; median rib is straight and is wider anteriorly in the region of the muscle scars. The greatest width is at mid-length. The hinge is strongly amphidont. Juveniles are poorly calcified.

Variation: This is a variable species which is large and inflated in the Middle Albian. During the Upper Albian it becomes smaller and less inflated with less pronounced ribs. Populations in the Middle Albian are of similar size. In the Upper Albian populations are of variable size, this variation in size of populations starts in the D.cristatum Subzone. Pitting is also very variable. Specimens in the Middle Albian tend to be more strongly pitted than those in the Upper Albian. This pitting may cover the whole lateral surface. Juveniles -1 may be smooth or reticulate.

Remarks: This is the most confused of all Albian ostracod species and minimal agreement has been reached regarding its taxonomy. It has been assigned six generic, two subgeneric, eight specific, and four subspecific names. This species was confused by the early workers many of whom gave juveniles of it specific status. The variable pitting and inflation of specimens has led to the majority of recent confusion.

Jones (1870) first described this species but did not figure it. Subsequently Jones & Hinde (1890) figured specimens of this species from the Gault Clay of Folkstone and the 'chalk detritus' of Charing. Triebel (1938a), Deroo (1956) and Moullade (1961) all described junior synonyms of this species because they did not consult the type material. Kaye (1964c) resolved most of the problems by defining a lectotype and paralectotype for this species from the Gault Clay of Folkestone and from the Charing 'detritus'. These specimens were all originally figured by Jones (1849). However, since the lectotype

defined by Kaye is from an unknown horizon within the Gault Clay and since it is a juvenile specimen the true nature of this species is difficult to ascertain. This problem must be resolved fully before subspecies can be accurately defined. The paralectotypes defined by Kaye are of both Albian and Cenomanian age.

The variation in size of specimens which has caused much of the taxonomic confusion is summarised below:-

|                                      | L.V. Length, Female | L.V. Length, Male |
|--------------------------------------|---------------------|-------------------|
| Kaye (1964)                          | 0.86-0.90 m.m.      | 0.96-1.00 m.m.    |
| Gründel (1966) <u>M.h.harrigiana</u> | 0.78                | 0.84              |
| <u>M.h.inflata</u>                   | 0.89                |                   |
| Damotte (1971)                       | 0.88-0.90           | 0.94-1.00         |
| Weaver (MS.)                         | 0.703               | 0.85              |
| Present work                         | 0.71-0.96           | 0.81-1.02         |

The slight sexual dimorphism that Kaye (1964c) recorded in juveniles is probably a result of this size variation in populations which is also reflected in the juveniles of this species.

This species differs from the closely related M.muelleri Gründel, 1964 in being more inflated laterally and bearing more sharply defined ribs.

Stratigraphic conclusion: This is one of the commonest of Albian species. It has been recorded from the upper Lower Albian through to the Cenomanian. It occurs ubiquitously across northwest Europe and is of limited stratigraphic significance. Neale (1978) recorded this as characteristic of the Middle and Upper Albian and of the Lower Cenomanian.

Mandocythere lapparenti (Damotte & Grosdidier, 1963)

(pl.23,figs.9,11,12,14.)

1963 Protocythere? lapparenti Damotte & Grosdidier:53,pl.2,figs.4a-g

1964c Veenia barringtonensis Kaye:60,pl.6,figs.1-3

1971b Protocythere (Mandocythere) lapparenti Damotte & Grosdidier;  
Damotte:91,pl.5,fig.21

Diagnosis: A species of Mandocythere with a strong posterior hinge node and a well developed, dorsally concave, ventral rib.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 303 | L.V. Female | 0.71m.m. | 0.49   | 0.26  |
| 304 | R.V. Female | 0.84     | 0.48   | 0.29  |
| 305 | L.V. Male   | 0.84     | 0.48   | 0.29  |
| 306 | R.V. Male   | 0.89     | 0.43   | 0.29  |

Description: A sub-rectangular species with a straight dorsal margin, strong hinge ear, and prominent postero-ventral hinge node. The anterior margin is broadly curved; ventral margin distinctly concave; posterior margin blunt. Marginal denticulation is present anteriorly. In the right valve the posterior margin is drawn out into a point. Three prominent longitudinal ribs are present on the lateral surface. The lateral surface slopes towards the dorsal margin, this slope is very pronounced in anterior view. In this view the valve appears sub-triangular. The anterior rib is dorsally convex; median rib is the weakest of the three and is wider anteriorly in the region of the muscle scars. The posterior rib is strongly concave dorsally and extends from the antero-dorsal margin to near the posterior margin. This rib runs parallel to the ventral and postero-ventral margins. The ribs converge posteriorly and almost meet. The greatest width occurs at the mid-length of the valve. Males are longer than females. The lateral surface is smooth.

Remarks: Both Damotte & Grosdidier (1963) and Kaye (1964c) recognised this as a new species. The name of Damotte & Grosdidier takes precedence. Kaye recorded this species from the topmost Gault

Clay of Barrington which is of S.dispar zonal age. Damotte recorded it from the C.auritus Subzone and from the M.mantelli Zone. Weaver (MS.) did not record this species from the Cenomanian of Southern England.

This species differs from others of the genus in having prominent, strongly curved, longitudinal ribs and a posterior hinge node.

Stratigraphic conclusion: This species has only been recorded from the C.auritus to the M.mantelli interval of the Anglo-Paris Basin. In Southern England it has only been recorded from the M.rostratum Subzone. This species is of major, local, stratigraphic significance.

Mandocythere muelleri (Gründel, 1964),

(pl.23,figs.4-8)

1964b Veenia (Mandocythere) muelleri Gründel:853,pl.1,figs.13,14

1966 Mandocythere (Mandocythere) muelleri (Gründel);Gründel:30,pl.5,  
fig.12,13

Diagnosis: A sub-rectangular, compressed, species of Mandocythere which has a flattened posterior margin.

|                                  | Length   | Height | Width |
|----------------------------------|----------|--------|-------|
| 307 L.V. Male                    | 0.82m.m. | 0.45   |       |
| 308 <del>Carapace</del> , Female | 0.76     |        | 0.40  |
| 309 L.V. Male                    | 0.78     | 0.54   |       |

Description: A sub-rectangular species with a straight dorsal margin and a broadly curved anterior margin. The ventral margin is gently curved anteriorly but strongly curved postero-ventrally. The posterior margin is blunt with a short margin between the posterior extremity and the well developed postero-dorsal cardinal angle. It is very poorly inflated. The lateral surface bears three inflated longitudinal ribs. The dorsal marginal rib is strongly developed; hinge ear prominent. Nine or ten marginal denticles are

present antero-ventrally. The dorsal rib is strongly inflated posteriorly and is joined to the anterior marginal rib which slopes strongly towards the anterior margin. The median rib is inflated. This rib is more inflated in the area of the muscle scars. The posterior end of this rib is connected to the posterior inflation of the dorsal rib. The ventral rib is inflated but indistinct. Greatest width at mid-length. Males are longer than females. The lateral surface is smooth.

Remarks: Gründel (1966) first described this species from the Albian of East Germany. He recorded it from the Middle and Upper Albian and Lower Cenomanian. It has a similar range to M.harrisiana in East Germany. Gründel noted that these two species are distinct and that this species differs from the latter in being less elongate and less inflated, having merged and not straight ribs, and in lacking nodes, spines, and pits.

In this study it was recorded in the Red Chalk (Upper Albian) of the southern North Sea Basin. It has only been recorded from the northern 'boreal' province.

Reticulate juveniles identical to H.reticulata Kaye, 1963 were recorded in populations with adults of this species. This ornament may be a common feature of juveniles of this genus.

Stratigraphic conclusion: A sporadically occurring species that ranges through from the Middle Albian to the Lower Cenomanian of the southern North Sea and German basins. It is of limited stratigraphic value.

Genus Veenia Butler & Jones, 1957

Type species: Cythereis ozanana Israelsky, 1929

Veenia florentinensis Damotte, 1961

(pl.23, figs.15,16)



- 1961 Veenia (Protoveenia) florentinensis Damotte:102,pl.1,figs.1-3;  
p1.3,figs.1-6
- 1965b Veenia cf. florentinensis Damotte;Kaye:45,pl.8,fig.1
- 1965c Veenia florentinensis Damotte;Kaye:246,pl.11,figs.1-8
- 1971b Veenia (Protoveenia) florentinensis Damotte;Damotte:97,pl.6,  
fig.9,text.fig.15

**Diagnosis:** A small, elongate, strongly ribbed species of Veenia which has strongly arched dorsal and ventral ribs.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 315 L.V. Female | 0.56m.m. | 0.31   | 0.15  |
| 316 R.V. Female | 0.55     | 0.30   | 0.13  |

**Description:** A sub-triangular species with a straight dorsal margin, strong anterior hinge ear, and weak posterior hinge ear. The anterior margin is broadly curved; ventral margin sinuous, slightly concave at its mid-point; posterior margin bluntly pointed. The lateral surface bears three strongly developed longitudinal ribs. The dorsal rib partially obscures the dorsal margin, it is strongly arched and extends two-thirds the valve length. The apex of this arch is slightly to the posterior of the hinge ear. The hinge ear bears a weak rib which extends in a ventral direction and joins the anterior end of the dorsal rib. The median rib is gently curved and is more inflated at its posterior end. The ventral rib is strong and is dorsally concave. The dorsal and ventral ribs converge towards the posterior. The ventral margin is weakly developed in the left valve. Sexual dimorphism is strong in Upper Albian specimens.

**Variation:** Both the size and the sexual dimorphism of populations is variable. The specimens from the marginal facies of both Seaton and Cauville are larger with more inflated longitudinal ribs than the typical Middle Albian specimens. Specimens from these

localities are also strongly sexually dimorphic. Sexual dimorphism was not observed in the Middle Albian specimens.

Remarks: Damotte (1961) first described this species from the H.dentatus Zone of the Paris Basin. She placed it in the new subgenus Veenia (Protoveenia) which was mainly defined on the scarcity of radial pore canals. Kaye (1965c) recorded this species from the Middle and Upper Albian. He noted that the marginal Upper Albian specimens are larger and variable in size and that the largest specimens differ slightly from the smaller ones. However, specimens of typical Lower Gault size and features occur together with them in the same sample. He recorded that the larger ones have more radial pore canals than the smaller ones and regarded the subgenus Protoveenia "unusable". Kaye further remarked that he thought the number of radial pore canals to be a direct function of size and that although no sexual dimorphism was apparent in the Lower Albian specimens it was present in Upper Albian specimens.

In the present study this species was recorded from the Middle Albian of southeast England and from the M.inflatum Zone of Seaton and Cauville. These specimens show similar variation in morphology to that described by Kaye. Damotte (1971b) retained the genus Protoveenia but stated that she had not studied the material of Kaye.

Stratigraphic conclusion: This species has been recorded from the Middle and Upper Albian of the Anglo-Paris Basin. In Southern England it occurs most abundantly but sporadically in the A.intermedius Subzone. It was also recorded rarely in the Red Chalk (Upper Albian) of the southern North Sea Basin. It occurs most commonly in the more marginal facies and is therefore of limited stratigraphic significance.

Genus Neocythere Mertens, 1956

During this study a large amount of variation was recorded in the strength and type of hingement in species of the genus Neocythere. The nature of these variations was first documented by Gründel (1966) who recorded the change in hingement of both Neocythere vanveeni Mertens, 1956 and N.denticulata (Mertens, 1956). Previous to this Mertens (1956) and Kaye (1963a) had subdivided this genus into distinct subgenera based on hingement. Neither of these authors recorded the 'evolution' of the hingement in this genus and these divisions may therefore be arbitrary.

Plate 27 illustrates the degree and type of variation in the hingement of this genus during the Albian. It is here concluded that there are three main types of hingement although some of these are certainly gradational (e.g. N.denticulata to N.semiconcentrica (Mertens, 1956)). N.vanveeni also shows minor variations in hingement (Gründel, 1966) as it loses the antero-median tooth in the left valve in the uppermost Albian and Cenomanian.

The variation recorded in the hingement of the right valves of specimens is summarised below:-

1) N.vanveeni type hinge. This consists of two prominent terminal teeth; both are strongly crenulate arched ridges. A prominent smooth anteromedian socket and a strongly crenulate postero-median groove separate these teeth.

2) N.denticulata type hinge. Another species with this type of hinge is Neocythere sp.A.sp.nov. Weaver, (MS.). This hinge type consists of a strongly amphidont hinge which has a strong anterior tooth with a distinct step anteriorally. The posterior tooth is a strongly crenulate arched ridge. The antero-median element is a prominent smooth socket; the postero-median element is a smooth or weakly crenulate groove.

3) N.semiconcentrica type hinge. Other species with this type of hinge are: N.steghausi Mertens, 1956, N.hieroglyphica Kaye, 1963, N.tenuis Kaye, 1964 and Neocythere sp.C.sp.nov. This hinge type is strongly merodont and consists of two low, arched, crenulate terminal teeth separated by a strongly crenulated groove.

There is also one intermediate hingement which occurs between types one and two. This has a multiple, stepped, anterior tooth which has a steeply sloping anterior margin. This tooth becomes less prominent in younger specimens of N.denticulata and becomes more rounded (pl.27,figs.11-14) and strongly merodont. The antero-median socket also gradually disappears and the postero-median element becomes more strongly crenulated (pl.27,fig.5).

The variation of hinge type within this genus is great, but there are three distinct hinge types which conform to the three subgenera that have previously been erected by Mertens (1956) and Kaye (1963a). These are therefore retained. Minor variation in the hingement are not regarded by the present author as of either specific, or subspecific, significance. The much stronger hingements in the marginal greensand facies, and the decrease in the strength of hingement through the Gault Clay, both indicate the adaptive nature of the hingement in this genus.

Subgenus Neocythere (Neocythere) Mertens, 1956

Type species: Neocythere vanveeni Mertens, 1956

Neocythere (Neocythere) vanveeni Mertens, 1956

(pl.26,figs.4,5,6,8;pl.27,fig.1.)

1849 Cythere punctatula (Roemer); Jones:11,pl.1,fig.2b(?figs.2a,e,e',  
i,l,m.); (non figs.2c,d,d',f-h,j,k,n.)

1890 Cytheropteron concentricum (Reuss); Jones & Hinde:31,pl.1,fig.7  
(?figs.8-10); (non pl.1,figs.5,6)

1956 Neocythere vanveeni Mertens:205,pl.12,figs.72-78;pl.14,figs.

100-102

1962 Neocythere vanveeni Mertens;Ellermann:400,figs.11,12

1963a Neocythere (Neocythere) vanveeni Mertens;Kaye:276,pl.41,figs.

23,25

1964b Neocythere (Neocythere) vanveeni Mertens;Kaye:324,pl.55,fig.13

1964c Neocythere (Neocythere) vanveeni Mertens;Kaye:pl.1,fig.10

1966 Neocythere vanveeni Mertens;Gründel:32,pl.5,fig.23

1966 Neocythere vanveeni ventrocostata Mertens;Gründel:32,pl.5,fig.18

1966 Neocythere? pseudovanveeni Gründel:33,pl.6,figs.3,4

1971b Neocythere (Neocythere) vanveeni Mertens;Damotte:101,pl.7,fig.1,

text fig.18a

1971 Neocythere vanveeni Mertens;Keen & Siddiqui:63,pl.1,fig.10

1978 Neocythere (Neocythere) vanveeni Mertens;Van der Wiel:pl.2,

figs.12,13

1978 Neocythere (Neocythere) vanveeni Mertens;Neale:pl.10,fig.8

Diagnosis: A subovate species of Neocythere (Neocythere) with a concentrically grooved lateral surface and a weak sub-central tubercule.

|     |                 | Length   | Height | Width |
|-----|-----------------|----------|--------|-------|
| 330 | L.V. Female     | 0.59m.m. | 0.36   | 0.27  |
| 331 | L.V. Male       | 0.66     | 0.37   | 0.24  |
| 332 | R.V. Female     | 0.62     | 0.35   | 0.24  |
| 333 | Dorsal C.Female | 0.58     |        | 0.42  |

Description: A subovate species with a strong ventral inflation. All the margins are curved, the dorsal margin broadly; anterior margin strongly; posterior margin bluntly. The ventral margin is sinuous, slightly concave at its mid-length. A smooth sloping shelf extends from the posterior extremity of the valve along the dorsal margin

where it is narrow. The inflated lateral surface obscures the ventral margin. It bears a series of concentric grooves and a weak sub-central tubercle. This surface is dominated by a dorsally concave, prominent, groove which occurs along the crest of the inflation. This groove truncates other grooves in the mid-lateral area. The hinge in the right valve consists of two crenulate terminal teeth with four or five toothlets. The median element of the left valve consists of a knob-like antero-median tooth and a well developed, clearly crenulate, postero-median bar.

Variation: Both the size of the carapace and the strength of ornament of this species are variable. The tooth of the right valve is absent in specimens from the S.dispar Zone.

Remarks: Early taxonomic records of this species are confused and not until the work of Mertens (1956) were these resolved. Kaye (1963a) noted that the amphidont nature of the hinge is not always apparent in the left valve but always in the right valve. Gründel defined both a new species, N. (N?) pseudovanveeni and a new subspecies, N.(N.) vanveeni ventrocostata, based on this variation. This variation in hingement has already been discussed in relation to the taxonomy and these two new forms are regarded as synonymous with N.(N.) vanveeni.

This species was recorded by early workers from the Gault Clay and 'Glaconitic Marl'. Mertens recorded it as typical of the Upper Albian of northwest Germany. He stated that it ranged from the Middle Albian to the Middle (?) Cenomanian. Subsequently it has been recorded from East Germany, France, and England. It has been recorded from all the Albian substages and from the Lower and Middle Cenomanian up to the level of the mid-Cenomanian non-sequence.

Bertram & Kemper (1971) utilised the new forms defined by Gründel in the 1966 zonal scheme which they proposed.

Stratigraphic conclusions: This species has been recorded from

the upper Lower, Middle and Upper Albian. It ranges into the Cenomanian and is of moderate stratigraphic significance.

Subgenus Neocythere (Centrocythere) Mertens, 1956

Type species: Centrocythere denticulata Mertens, 1956

Neocythere (Centrocythere) denticulata Mertens, 1956

(pl.24,figs.9,11-13;pl.27,figs.5-7,11-18.)

- 1849 Cythere punctatula (Roemer);Jones:11 (? pl.1,figs.2c,d,f-h,k-m.)
- ?1870 Cytheropteron concentricum (Reuss);Jones:74,76
- 1890 Cytheropteron concentricum (Reuss);Jones & Hinde:31,(?pl.1,figs. 6,8-10).
- 1956 Centrocythere denticulata Mertens:204,pl.11,figs.66-71:pl.14, figs.97-99
- 1962 Centrocythere denticulata Mertens;Ellermann:406,figs.10a-c
- 1963a Neocythere (Centrocythere) denticulata Mertens;Kaye:280,pl.41 fig.13
- 1964c Neocythere (Centrocythere) denticulata Mertens;Kaye:47,pl.1, figs.8,13
- 1966 Centrocythere denticulata Mertens;Gründel:33,pl.5,fig.22
- 1971b Centrocythere denticulata Mertens;Damotte:101,pl.6,fig.16
- 1978 Centrocythere denticulata Mertens;Van der Wiel:pl.2,figs.9-11
- 1978 Neocythere (Centrocythere) denticulata Mertens;Neale: pl.10, fig.7

Diagnosis: A sub-ovate, ventrally inflated, species of Neocythere (Centrocythere) which has a lateral surface covered by concentric, curved, rows of reticulation.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 350 | L.V. Female | 0.60m.m. | 0.41   | 0.23  |
| 351 | R.V. Female | 0.63     | 0.45   | 0.21  |

|     |           |      |      |      |
|-----|-----------|------|------|------|
| 352 | L.V. Male | 0.62 | 0.35 | 0.20 |
| 353 | R.V. Male | 0.56 | 0.35 | 0.18 |

**Description:** A subovate species that is ventrally inflated. The dorsal margin is straight along its mid-length but curves antero-dorsally, the anterior margin is strongly curved. The ventral margin is sinuous, slightly curved at its mid-length; posterior margin blunt; postero-dorsal margin curved. Strong denticulation is usually present anteriorly. A small, smooth, sloping shelf is present at the posterior valve extremity. The lateral surface is covered by concentric rows of pits which extend from the dorsal margin and curve over the ventral inflation and back to the dorsal margin. The ventral margin is obscured by the ventral tumidity. Small spines are present at the junctions of the ridges which separate the pits. Males are longer and narrower than females.

The hinge is amphidont. The anterior tooth in the right valve is stepped, the posterior tooth is low and crenulate. The posterior median element is crenulate and consists of a bar in the left valve which has a large accommodation groove above it.

**Variation:** The hinge in this species is variable and is gradational to a merodont hinge (pl.27,figs.11-15,17) in the C. auritus Subzone of southern England. During this transition it passes through an intermediate hinge type which has previously been discussed.

**Remarks:** This species is externally very similar to N. (P.) semiconcentrica but can be easily distinguished from the latter by its amphidont hinge. It was originally described by Mertens (1956) from the Middle Albian of northwest Germany. Gründel (1966) also recorded it from the Middle Albian in East Germany. Kaye (1964c) did not record the latter species and it must be assumed that he included specimens of this in his concept of N. (C.) denticulata, although he did not indicate this in his synonymy. He also stated that nearly all the



specimens from the Albian (Gault) belong to this species while those from the basal Cenomanian (Charing) can be referred to N. (N.) vanveeni Mertens. However, it has been shown by Weaver (MS.) that N. (C.) denticulata does not occur in the Cenomanian of Southern England. Thus the specimens that Kaye referred to from the Lower Cenomanian of Charing are probably N. (P.) semiconcentrica and not N. (C.) denticulata.

Mertens (1956) described this species co-existing with N. (P.) semiconcentrica in the Middle Albian of Germany while Gründel (1966) regarded them as chronospecies and noted that the boundary between these two chronospecies occurred in the middle Middle Albian. In this study these species are regarded as chronospecies with the change occurring in the middle of the C. auritus Subzone. The relationship between these two species is thus very complex and may be environmentally controlled.

Damotte (1971b) recorded this species from the H. dentatus Zone to the M. inflatum Zone in the Paris Basin.

Stratigraphic conclusion: This species occurs in the Lower, Middle, and lower Upper Albian. In the Anglo-Paris Basin it last occurs in the lower part of the C. auritus Subzone. In southern England it first appears in the A. intermedius Subzone. It is of major stratigraphic significance in the Anglo-Paris Basin.

Subgenus Neocythere (Physocythere) Kaye, 1963

Type species: Cythere lingenensis Mertens, 1956

Neocythere (Physocythere) hieroglyphica Kaye, 1963

(pl.26, fig.13.)

1963a Neocythere (Physocythere) hieroglyphica Kaye:279, pl.41, figs.

8-12, 14

1978 Neocythere (Physocythere) hieroglyphica Kaye; Neale: pl.10

fig.11

Diagnosis: A large species of Neocythere (Physocythere) with a strongly ribbed lateral surface and a prominent marginal shelf in the left valve.

|                 | Length   | Height | Width |
|-----------------|----------|--------|-------|
| 343 R.V. Female | 0.70m.m. | 0.38   | 0.24  |

Description: A large, ventrally inflated species with a slightly concave dorsal margin in the left valve; strongly curved anterior margin and sinuous ventral margin. The posterior margin is bluntly pointed. A wide marginal shelf extends along the posterior, dorsal, and anterior margins. In the right valve this shelf is absent and the dorsal margin is long and straight. The postero-dorsal margin is slightly concave in the left valve and strongly so in the right valve. The lateral surface is very strongly ribbed and these ribs, according to Kaye, form a hieroglyphic pattern. The valves are strongly calcified. The hinge is strongly merodont.

Remarks: This species has been considered synonymous with N. (P.) steghausi by both Gründel (1966) and Weaver (MS.). It differs from the latter in the presence of a large marginal shelf in the left valve. No intermediate forms between these two species were recorded and, therefore, they have been retained as separate species. This species was recorded by Neale (1978) from the C. auritus Subzone and the S. dispar Zone of England.

Stratigraphic conclusion: A rare species which is limited in distribution to the Red Chalk facies of the North Sea Basin. It is of limited stratigraphic value.

Neocythere (Physocythere) semiconcentrica (Mertens, 1956)

(pl.26,figs.1-3,7,10;pl.27,figs.9,10.)

1849 Cythere punctulata (Roemer); Jones:11,pl.1(? figs.2a,c-h,k); (non  
figs.5,7,10)

- 1890 Cytheropteron concentricum Jones & Hinde:31,pl.1.(? figs.6,8,9);  
(non figs.2b,i,j,l-n.)
- 1893 Cytheropteron semiconcentricum (Reuss);Chapman & Sherborn:347
- 1956 "Cythere" semiconcentrica Mertens:186,pl.9,figs.15-18
- ?1956 Brachycythere concentrica (Reuss);Deroo:1512,pl.3,figs.35,36
- 1962 Cythere semiconcentrica Mertens;Ellermann:397,figs.5,6
- 1966 Physocythere semiconcentrica Mertens;Gründel:31,pl.5,figs.19-22

Diagnosis: A sub-ovate species with a concentrically pitted lateral surface and symmetrical hinge elements.

|     |                 | Length   | Height | Width |
|-----|-----------------|----------|--------|-------|
| 336 | L.V. Male       | 0.62m.m. | 0.39   |       |
| 337 | L.V. Female     | 0.62     | 0.42   |       |
| 338 | L.V. Female     | 0.58     | 0.38   |       |
| 339 | R.V. Female     | 0.58     | 0.34   | 0.17  |
| 340 | Dorsal C.Female | 0.52     | 0.37   |       |

Description: This species is very similar in external morphology to N. (C.) denticulata but lacks the spines on the lateral surface. It differs mainly in having a merodont and not an amphidont hinge. This consists, in the right valve, of two strongly crenulate terminal teeth separated by a long straight locellate groove. Males are longer and have straighter dorsal margins than females. They also have a node in the area of the eye tubercule.

Variation: The main variation in this species is in hingement which has been illustrated (pl.27). These figures show a gradational change from a strong amphidont hinge to a strong merodont hinge. This change in hingement occurs within the C.auritus Subzone of southern England. This hingement evolves through several intermediate hinge types which have previously been discussed.

Remarks: This species can easily be differentiated from N. (C.) denticulata by its hinge. In southern England these two species are

stratigraphically mutually exclusive; the change in hingement occurs in the C. auritus Subzone. However, Mertens (1956) described these two species co-existing in the Middle Albian of northwest Germany. In the Albian of East Germany Gründel (1966) recorded these two species as chronospecies, with this species first occurring in the upper Middle Albian and ranging through into the basal Cenomanian. Weaver (MS.) recorded it from the Lower and Middle Cenomanian up to the level of the mid-Cenomanian non-sequence.

This species appears to have a very complex relationship with N. (C.) denticulata which makes the first occurrence of N. (P.) semiconcentrica highly diachronous across northwest Europe.

Stratigraphic conclusion: In southern England this species first appears in the mid-C. auritus Subzone. It is of major, local, stratigraphic significance.

Neocythere (Physocythere) steghausi (Mertens, 1956)

(pl.26,fig.15;pl.27,figs.2,3.)

- 1956 "Cythere" steghausi Mertens:188,pl.9,figs.19-22
- 1956 Cythere steghausi Mertens;Ellermann:398,text figs.7a-c
- 1966 Physocythere steghausi Mertens;Gründel:32,pl.5,fig.11
- 1971 Physocythere steghausi Mertens;Bertram & Kemper:pl.2,fig.13

Diagnosis: A strongly ornamented, ventrally inflated, species of Neocythere (Physocythere) with a bluntly pointed posterior margin.

|                  | Length   | Height | Width |
|------------------|----------|--------|-------|
| 340a L.V. Female | 0.56m.m. | 0.35   | 0.21  |

Description: This ventrally inflated species has a straight dorsal margin, strongly curved anterior margin and a sinuous ventral margin which is obscured by the ventral tumidity. The posterior margin is elongated, truncated posteriorally, with straight postero-

dorsal and postero-ventral margins. A smooth posterior shelf is present. The lateral surface is covered by strong concentric ribs. The hinge in the right valve consists of two, low, terminal, strongly crenulate teeth. These are separated by a locellate groove.

Remarks: This species is very closely related to N. (P.) hieroglyphica Kaye, 1963 and was thought to be conspecific with it by Gründel (1966). Gründel stated that the specimens figured by Kaye are identical to the figured specimens and description given by Mertens (1956) for this species. However, the figured left valve of Kaye has a prominent posterior, dorsal, and anterior marginal shelf, and a greatly elongated posterior margin. These features are not visible on the figured specimens of Mertens and they are, therefore, retained as separate species.

N. (P.) steghausi occurs in the S. dispar Zone of southeast England where it is distinctly smaller than the figured specimens of Mertens. Weaver (MS.) recorded this species from the lowest few metres of the Cenomanian of southern England. Gründel gave the range of this species as Upper Albian, as did Mertens (1956). Bertram & Kemper (1971) only recorded this species in the S. dispar Zone.

Stratigraphic conclusion: This species has been recorded from the S. dispar Zone and from the lowest Cenomanian of southern England. It is limited to the Upper Albian across northwest Europe and is locally of major stratigraphic significance.

?Neocythere (Physocythere) tenuis Kaye, 1965

(pl. 26, fig. 9)

1965c Neocythere (Physocythere) tenuis Kaye: 245, pl. 6, figs. 14-17

1978 Neocythere (Physocythere) tenuis Kaye, Neale: pl. 10, fig. 10

Diagnosis: A small, poorly calcified, weakly ornamented,

species of ?Neocythere (Physocythere) with a weak hinge.

|                 | Length    | Height | Width |
|-----------------|-----------|--------|-------|
| 344 R.V. Female | 0.41 m.m. | 0.25   | 0.11  |

Description: A small, sub-ovate species with a gently convex dorsal margin; in right valve dorsal margin straight. Ventral margin weakly convex, dorsal and ventral margins converge slightly posteriorally. Anterior margin broadly rounded, posterior margin bluntly rounded. The lateral surface is inflated; covered by fine, dense pitting. Duplicature narrow, hinge weak in left valve having two faintly divided sockets separated by a weakly denticulate bar. The muscle scars consists of a row of 4 oval scars and a 'U' shaped antennal scar.

Remarks: Only one specimen was recorded in this study and this shows very limited similarity to any of the other species of this genus. Owing to the lack of material it was retained in the subgenus Neocythere (Physocythere). The weakness of the hinge may indicate that this is a juvenile specimen. However, it is not a juvenile of any of the adult forms recorded in this study. The weak hinge is similar to that recorded in early forms of the genus Loxoconcha Sars, 1866.

This species was first recorded by Kaye, 1964c from the A. intermedius Subzone of Henfield, Sussex.

Stratigraphic conclusion: This species is very rare in the Middle Albian of southern England and is only of limited stratigraphic significance.

Neocythere (Physocythere) sp.A. Weaver MS.

(pl.26, figs.14,16,17)

Diagnosis: A small species of Neocythere (Physocythere) with a

faintly ribbed lateral surface and a straight postero-dorsal margin in the right valve.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 345 | L.V. Female | 0.60m.m. | 0.39   | 0.24  |
| 346 | R.V. Female | 0.59     | 0.38   | 0.23  |
| 347 | R.V. Male   | 0.63     | 0.32   | 0.20  |

Description: A small, sub-ovate, weakly calcified species; dorsal margin is slightly arched; anterior margin sharply rounded; ventral margin very weakly convex; posterior margin sharply rounded with a straight postero-dorsal margin. The lateral surface is inflated and slightly obscures the ventral margin which bears a number of weak concentric ribs.

The hinge in the right valve consists of two low, crenulate, terminal teeth which are separated by a long, weakly crenulate median bar. The inner lamella is weak with vestibulae both anteriorally and posteriorally.

Remarks: This species is very similar to N. (N.) vanveeni from which it differs in the type of hingement and in the strength of ribbing. It is similar to N. (P.) sp.A. that Weaver (MS.) recorded from the lowest few metres of the Cenomanian. It was recorded in the present study from the S.dispar Zone of southern England.

Stratigraphic conclusion: This species occurs sporadically in the S.dispar Zone and lowest Cenomanian of southern England. It is of limited stratigraphic value.

Neocythere (Physocythere) sp.C. sp.nov.

(pl.27, fig.4; pl.28, figs.1,3)

Diagnosis: This species is externally similar to N. (C.) posterospinosa but differs in having a strongly merodont hinge.

|     |             | Length   | Height |
|-----|-------------|----------|--------|
| 348 | L.V. Female | 0.38m.m. | 0.25   |
| 349 | R.V. Female | 0.38     | 0.23   |

Remarks: This species, which is externally very similar to N.(C.)posterospinosa Weaver (MS.), was only recorded in association with the latter species in the marginal facies of the Upper Albian from Seaton, Devon.

Stratigraphic conclusion: A rare species which was only recorded from the marginal Upper Greensand of Seaton, Devon. It is of limited stratigraphic value.

Neocythere (Centrocythere) posterospinosa Weaver MS.

(pl.26, figs.11,12;pl.27,fig.8.)

Diagnosis: A large, subovate, strongly calcified, species of Neocythere (Centrocythere) with weak concentric ribs and a straight dorsal margin.

|     |             | Length  | Height | Width |
|-----|-------------|---------|--------|-------|
| 355 | L.V. Female | 0.74m.m | 0.49   | 0.30  |
| 356 | R.V. Female | 0.73    | 0.46   | 0.31  |

Description: A ventrally inflated species with a straight dorsal margin; anterior and posterior margins sharply rounded; dorsal margin appears strongly arched with greatest height at two-fifths length. The ventral inflation partially obscures the ventral margin and is covered by weak concentric ribs. From the posterior part of the lateral surface seven or eight small spines protrude from the weak ribs. These are directed posteriorally.

The hinge in the right valve consists of two strong terminal teeth. The anterior tooth is strongly developed and 'knob-like', the posterior tooth is long, low and strongly crenulate. These two



teeth are separated by a strongly crenulate median groove which has a large socket at its anterior end.

Remarks: This species was first described by Weaver (MS.) from the Lower Cenomanian of southern England. He recorded it as rare. It differs from both N. (N.) vanveeni and N. (P.) sp.A. in its hingement and was found in association with N. (P.) sp.A. in the marginal facies of Seaton, Devon (M. inflatum Zone).

Stratigraphic conclusion: A rare species which has only been recorded from the Upper Albian and Lower Cenomanian of southern England. It is of limited stratigraphic value.

Sub-family CYTHEREIDEINAE Sars, 1925

Genus Clithrocytheridea Stephenson, 1936

Type species: Cytheridea (?) garretti Howe & Chambers, 1935

Clithrocytheridea heslertonensis Kaye, 1963

(pl.28,figs.2,6;pl.30,fig.9)

1963c Clithrocytheridea heslertonensis Kaye:30,pl.1,figs.1 $\frac{1}{2}$ -13

1963 Clithrocytheridea ? ventricola Damotte & Grosdidier:53,pl.1,  
figs.1a-f

1965c Clithrocytheridea heslertonensis Kaye;Kaye:228,pl.1,figs.8-12

1971b Clithrocytheridea heslertonensis Kaye;Damotte:108,pl.7,fig.13

1978 Clithrocytheridea heslertonensis Kaye;Neale:pl.9,figs.12-14;  
pl.10,figs.1,2

Diagnosis: A strongly inflated, oval, species of Clithrocytheridea which has a smooth ventral surface.

|      |             | Height | Length |
|------|-------------|--------|--------|
| 370a | R.V. Female | 0.85   | 0.55   |
| 370b | R.V. Female | 0.89   | 0.55   |

Description: A large species of this genus; valves strongly

inflated laterally and slightly tumid ventrally. The dorsal margin is strongly arched with a strong cardinal angle posteriorly. Greatest height and width at two-fifths length. The anterior margin is broadly rounded and the posterior margin is sub-triangular. The lateral surface is smooth and bears a number of simple pores. In dorsal view the carapace is strongly bi-convex with a prominent marginal rib anteriorly. Sexual dimorphism is well marked with males being much longer in proportion to their height than females.

Remarks: Kaye (1963c) first described this species from the Middle Albian of Yorkshire. Damotte & Grosdidier (1963) also recognised this as a distinct species which they first recorded from the D.mammillatum Zone of the Aube. Kaye (1965c) stated that he had examined specimens of C.? ventricola Damotte & Grosdidier, 1963 and had concluded that these two forms are synonymous. The name of Kaye thus takes precedence. He also stated that he recorded this species abundantly in the H.spathi Subzone of the Lower Gault and that it appears to be confined to this Subzone. In the present study this species was only recorded in the A.intermedius and D.niobe Subzone of southern England.

Stratigraphic conclusion: This species occurs very rarely in the upper Lower and lower Middle Albian of the Anglo-Paris Basin. It has also been recorded from the Middle Albian of northern England. It is of limited stratigraphic value.

Clithrocytheridea aff. Haplocytheridea nana (Triebe1, 1936)

(pl.28.4,5,8-10,13)

1938b Cytheridea (Haplocytheridea) nana Triebe1:491,pl.3,figs.58-62

1956 Haplocytheridea ? nana Triebe1;Mertens:195,pl.10,figs.41-44

1963c ? Clithrocytheridea aff. Haplocytheridea nana Triebe1;Kaye:  
30,pl.1,figs.14,15

1966 Haplocytheridea ? nana Triebe1;Gründel:101,pl.3,fig.3

Diagnosis: A small, strongly dimorphic, species with a strongly arched dorsal margin.

|     |                    | Length   | Height | Width |
|-----|--------------------|----------|--------|-------|
| 475 | L.V. Female        | 0.34m.m. | 0.25   | 0.10  |
| 476 | L.V. Female        | 0.36     | 0.26   | 0.11  |
| 477 | R.V. Male          | 0.51     | 0.31   | 0.17  |
| 478 | L.V. Dorsal Female | 0.45     |        | 0.17  |
| 479 | L.V. Dorsal Male   | 0.53     |        | 0.16  |
| 480 | R.V. Female        | 0.35     | 0.23   | 0.10  |

Description: A small species with a strongly arched dorsal margin and a weakly convex ventral margin which in the male is weakly concave. Anterior margin strongly curved; posterior margin sharply rounded. Greatest height and width at one half length. The lateral surface is smooth and bears a number of simple pores; weakly arched in dorsal view, lateral surface strongly inflated.

Sexual dimorphism is strong, males are much larger in relation to their height than females. Greatest height occurs at one third length.

Variation: This species varies greatly in size. Middle Albian specimens are much larger than those from the topmost Albian.

Remarks: This species was first described from the N.minimus Zone of northwest Germany by Triebel (1938). Mertens (1956) subsequently recorded it from the Lower and Upper Albian of Germany. Kaye (1963c) recorded it from the Middle Albian of Speeton. In southern England this species first appears in the basal Middle Albian and ranges through to the Cenomanian. It occurs very abundantly in the A.intermedius Subzone where it forms a large proportion of the ostracod population. It only occurs very sporadically outside this Subzone.

Both Kaye (1963c) and Weaver (MS.) noted that the British

specimens of this species differ from those described by Triebel (1938) and Mertens (1956) in having a reversed hinge. The British specimens have thus been placed in Clithrocytheridea aff.

Haplocytheridea.

The abundance of this species appears to be strongly influenced by the environment. They occur in great abundance in the shallower water, clay facies, of southern England.

Stratigraphic conclusion: This species occurs very abundantly in the A.intermedius Subzone of southern England where it is of major stratigraphic significance. Across northwest Europe it ranges from the upper Lower Albian to the Cenomanian. It is generally of moderate stratigraphic significance.

Genus Dolocytheridea Triebel, 1938

Type species: Cytherina hilseana Roemer, 1841

Dolocytheridea bosquetiana (Jones & Hinde, 1890)

(pl.30.5,7,8)

1849 Bairdia angusta (Münster); Jones:26, pl.6, figs.a-f

1890 Pontocypris bosquetiana Jones & Hinde:4, pl.2, fig.65; pl.4, fig.3

1893 Pontocypris bosquetiana Jones & Hinde; Chapman & Sherborn:346

1938b Cytheridea (Dolocytheridea) bosquetiana (Jones & Hinde); Triebel:  
498, pl.5, figs.80-83; pl.6, fig.91

1956 Dolocytheridea bosquetiana (Jones & Hinde); Deroo:1511

1958 Dolocytheridea bosquetiana (Jones & Hinde); Oertli:pl.4, figs.45-47

1962 Dolocytheridea bosquetiana (Jones & Hinde); Ellermann:401, figs.14,15

1964c Dolocytheridea bosquetiana (Jones & Hinde); Kaye:46, pl.1, figs.

18-20

1966 Dolocytheridea bosquetiana (Jones & Hinde); Gründel:18, pl.2,  
fig.14

1971b Dolocytheridea bosquetiana (Jones & Hinde); Damotte:110, pl.7,  
fig.16

Diagnosis: A large species of Doloccytheridea with a straight or slightly convex ventral margin and with no cardinal angles. Greatest height at one quarter length.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 373 | R.V. Male   | 0.79m.m. | 0.32   | 0.20  |
| 374 | L.V. Male   | 0.73     | 0.35   | 0.17  |
| 375 | L.V. Female | 0.76     | 0.38   | 0.20  |

Description: A large species with a convex dorsal margin which is almost straight along the length of the hinge line. Anterior margin semi-circular; ventral margin straight, slightly concave at mid-length. Posterior extremity close to ventral margin, sharply rounded. Postero-dorsal margin long, weakly convex. Greatest height occurs at one quarter length; width at mid-length. Valves inflated. The lateral surface is smooth and slopes evenly towards valve margins. The ventral margin is steeply sloping. In dorsal view the carapace is ovate, flattened ventrally, and pointed dorsally. The valves are strongly dimorphic and sexual dimorphism is strong.

Variation: This species becomes smaller in the Upper Albian.

Remarks: This species was originally included in Bairdia angusta by Jones (1849) who figured specimens from the Gault Clay, Charing 'detritus' and Gravesend Chalk. It was recognised as a separate species by Jones (1890) who figured specimens from the Gault Clay of Folkestone and from the Chalk Marl. It has subsequently been fully documented by many authors who have recorded it in the Middle Albian to Lower Cenomanian of northwestern Germany and from the Middle and Upper Albian of the Paris Basin. Kaye (1964c) erected a lectotype from the Gault of Folkestone and para-lectotypes from the same locality. Kaye only recorded this species in the Upper Albian of southern England.

This species differs from D.intermedia Oertli, 1958 in being

longer and having a more convex lateral surface in dorsal view.

Weaver (MS.) recorded it from the 'Glaucinitic Marl' and from the lowest few metres of the Cenomanian Chalk of southern England.

Stratigraphic conclusion: This species occurs abundantly in the Middle and Upper Albian and lowest Cenomanian. In southern England it first occurs in the E.loricatus Zone and in the Aube it first appears in the H.dentatus Zone. It is of moderate stratigraphic value.

Dolocytheridea typica Kaye, 1965

(pl.30,fig.4.)

1965c Dolocytheridea typica Kaye:230,pl.3,figs.9-14

Diagnosis: A moderately sized species of Dolocytheridea with a strongly arched dorsal margin and an almost straight ventral margin.

|                 | Length   | Height |
|-----------------|----------|--------|
| 376 R.V. Female | 0.61m.m. | 0.38   |

Description: Valves moderately sized and inflated with a strongly arched dorsal margin; ventral margin straight; anterior margin narrowly rounded; posterior margin bluntly rounded. Lateral surface smooth; eye spot absent. The greatest height occurs at mid-length.

Remarks: Kaye (1965c) first described this species from the Upper Gault of Pinhay, Devon. It was recorded rarely in the present study.

Stratigraphic conclusion: A rare species that has only been recorded from the M.inflatum Zone of Devon. It is of limited stratigraphic value.

Genus Acrocythere Neale, 1960

Type species: Orthonotacythere hateriviana Bartenstein, 1956

Acrocythere hautoeriviana (Bartenstein, 1956)

(pl.28,fig. 7)

1956 Orthonotacythere hautoeriviana Bartenstein:532,pl.3,figs.80,81

1960 Orthonotacythere (Acrocythere) hautoeriviana anomala Bartenstein;

Neale:213, pl.3,figs.7a,b;pl.4,figs.10-14

1965a Acrocythere hautoeriviana (Bartenstein);Kaye:77,pl.5,figs.12,13,

15,16,text figs.1,2

1978 Acrocythere hautoeriviana (Bartenstein);Neale: pl.2,figs.4,5

**Diagnosis:** A strongly reticulate species of Acrocythere with four prominent median ribs and a weak median sulcus.

|          | Length   | Height |
|----------|----------|--------|
| 457 L.V. | 0.67m.m. | 0.34   |

**Description:** An elongate species with a prominent eye tubercule. A weak median sulcus extends dorsally. The dorsal margin is straight; anterior broadly curved; posterior bluntly pointed. Four prominent longitudinal frills are present on the lateral surface, of these the narrow ventro-lateral frill is best developed. This frill extends from below the mid-point of the anterior margin, it is weakly concave dorsally and obscures most of the ventral surface and part of the ventral margin. A shorter median longitudinal frill extends from one third the valve length to near the posterior margin. The dorsal marginal frill extends in a dorsal direction along the posterior half of the valve. A longitudinal rib is present along the ventral surface.

**Remarks:** This species was recorded by Neale (1978) as one of the commonest Lower Cretaceous ostracods which occurs essentially in the Hauterivian and Barremian but also in the Aptian. In the present study only one specimen was recorded from the clay facies of borehole 49/19-1. This could be an 'up-hole' (reworked) contaminant from the Aptian but it may indicate that this species also occurs in the

Albian.

Stratigraphic conclusion: A rare species of limited stratigraphic value.

Acrocythere striata Kaye, 1965

(pl.28,fig.11.)

1965c Acrocythere striata Kaye:244,pl.4,figs.4-10

Diagnosis: An elongate species of Acrocythere with ornamentation consisting of numerous longitudinal striae ridges.

|                 | Length   | Height |
|-----------------|----------|--------|
| 378 L.V. Female | 0.40m.m. | 0.21   |

Description: A small species with strongly compressed valves which are elongate-ovate in shape. The dorsal margin is weakly curved; ventral margin more strongly convex; anterior margin strongly curved; posterior margin pointed at mid-height. The greatest height occurs at one quarter length; greatest width at mid-length. The lateral surface is covered by a number of strong, longitudinal, striae ridges.

Remarks: Only two specimens were recorded in the present study. This species was first described from the basal Upper Gault of Pinhay, Devon by Kaye (1965c). This is the only previous record of this distinctive species which is characterised by the longitudinal ridges.

Stratigraphic conclusion: A rare species which has only been recorded from the marginal Upper Greensand of Devon. It is of limited stratigraphic value.

Genus Schuleridea Swartz & Swain, 1946

Type species: Schuleridea acuminata Swartz & Swain, 1946



Schuleridea dimorphica Kaye, 1965

(pl.29,figs.12-16)

1965c Schuleridea dimorphica Kaye:228,pl.5,figs.1-6

1978 Schuleridea dimorphica Kaye;Neale:pl.9,figs.4,5

Diagnosis: A small, strongly dimorphic, species of Schuleridea which lacks cardinal angles.

|     |                    | Length.  | Height | Width |
|-----|--------------------|----------|--------|-------|
| 385 | R.V. Male          | 0.57m.m. | 0.32   | 0.14  |
| 386 | L.V. Male          | 0.59     | 0.36   | 0.17  |
| 387 | R.V. Female        | 0.51     | 0.30   | 0.15  |
| 388 | L.V. Female Dorsal | 0.52     |        | 0.16  |
| 389 | L.V. Male Dorsal   | 0.57     |        | 0.15  |

Description: A small, subovate species which is laterally compressed. The dorsal margin is strongly arched in the left valve; in right valve it is broadly curved; cardinal angles absent in both valves. The anterior margin is strongly rounded; in the right valve it is bluntly rounded. The posterior margin is weakly pointed in both valves. Ventral margin broadly curved in the right valve; straight and slightly sinuous in the male. Greatest height occurs just in front of mid-length; greatest width at mid-length. The eye tubercle is weakly developed. Lateral surface is smooth, strongly pitted. Inner lamellae well developed; hinge well developed; in the right valve it consists of two bar-like denticulate teeth which are separated by a low median bar. The valves are strongly dimorphic. Males are much longer and higher than females and the left valves are more ovate than right valves.

Remarks: Kaye (1965) originally described this species from the H.orbignyi Subzone of Wrotham, Kent. He also noted that this species is easily distinguished from other similar species by its size and strong dimorphism. Kaye regarded it as an important index form of

the Upper Albian. In the present study it was recorded abundantly in the lower part of the Upper Albian and ranges from the A.intermedius Subzone to the S.dispar Zone.

Stratigraphic conclusion: This species occurs in the Middle and Upper Albian of southern England and northwest France. It is of moderate, local, stratigraphic significance.

Schuleridea jonesiana (Bosquet, 1852)

(pl.29,figs.1-5,8)

- 1849 Cythere hilseana (Roemer); Jones:10,pl.1,figs.1a-g
- 1852 Cytheridea jonesiana Bosquet:38
- 1890 Cytheridea perforata (Roemer); Jones & Hinde:29,pl.1,figs.1-4
- 1893 Cytheridea perforata (Roemer); Chapman & Sherborn:349
- 1893 Cytheridea perforata insignis Chapman & Sherborn:349,pl.14,  
fig.10
- 1893 Cytheridea rotunda Chapman & Sherborn:349,pl.14,fig.11
- 1893 Cythere? spinifera Chapman & Sherborn:348,pl.14,fig.3
- 1938b Cytheridea (Haplocytheridea) jonesiana Bosquet; Triebel:480,  
pl.2,figs.21-25
- 1954 Haplocytheridea jonesiana (Bosquet); Stchépinsky:pl.2,figs.13,14
- 1956 Schuleridea jonesiana (Bosquet); Mertens:193,pl.10,figs.38-40
- 1956 Schuleridea jonesiana (Bosquet); Deroo:1512,pl.2,figs.26,31
- 1958 Schuleridea jonesiana (Bosquet); Oertli:1507,pl.5,figs.105,113
- 1962 Schuleridea jonesiana (Bosquet); Ellermann:401,figs.13a-c
- 1963c Schuleridea jonesiana (Bosquet); Kaye:31,pl.2,figs.9-13
- 1964c Schuleridea jonesiana (Bosquet); Kaye:45,pl.1,figs.1-5
- 1966 Schuleridea jonesiana jonesiana (Bosquet); Gründel:22,pl.3,figs.  
12,13
- 1966 Schuleridea jonesiana foveata (Bosquet); Gründel:21
- 1971b Schuleridea jonesiana (Bosquet); Damotte:112,pl.8,fig.5

1978 Schuleridea jonesiana (Bosquet);Van der Wiel:pl.2,fig.15

1978 Schuleridea jonesiana (Bosquet);Neale:pl.8,fig.14,pl.9,figs.1-3

Diagnosis: A large species of Schuleridea with a strongly pitted surface and strong sexual dimorphism.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 379 | L.V. Female      | 0.88m.m. | 0.60   | 0.29  |
| 380 | L.V. Male        | 1.10     | 0.56   | 0.34  |
| 381 | R.V. Female      | 0.80     | 0.48   | 0.21  |
| 382 | Dorsal Female C. | 0.77     |        | 0.37  |
| 383 | L.V. Female      | 0.80     | 0.54   |       |
| 384 | R.V. Male        | 0.97     | 0.52   | 0.29  |

Description: This species has a strongly pitted surface and a prominent eye tubercule. The dorsal margin is strongly arched and lacks cardinal angles, the right valve has weak anterior and posterior cardinal angles and has a straight dorsal margin. The anterior margin is strongly rounded; posterior margin weakly pointed; ventral margin gently curved; in the right valve it is straight and sinuous. Marginal denticulation is present antero-ventrally and postero-ventrally in the right valve. Valves weakly inflated, greatest height and width at mid-length. Males are more ovate, longer and higher than females. In the hinge of the left valve a strong bar is present on the dorsal side of the median hinge groove.

Variation: The size of specimens varies and specimens from the marginal facies are more strongly calcified.

Remarks: This species has been recorded extensively and was originally included in Cythere hilseana (Roemer) by Jones. Bosquet (1852) recognised it but referred it to Cytheridea jonesiana. Both Jones & Hinde (1890) and Chapman & Sherborn referred this to the Tertiary species Cytheridea perforata Roemer. Kaye (1964c) resolved

the problems with the nineteenth century material and erected a lectotype from the original material of Jones (1894) from the Gault Clay of Folkestone and paralectotypes from the Gault Clay and Charing 'detritus'.

This species has been recorded commonly from the Albian and Lower Cenomanian of Germany and from the Upper Aptian to Lower Cenomanian of France. Weaver (MS.) recorded this species as common up to the level of the mid-Cenomanian non-sequence in southern England.

Stratigraphic conclusion: A common species that ranges through the Albian. It is of limited stratigraphic value.

Genus Habrocythere Triebel, 1940

Type species: Habrocythere fragilis Triebel, 1940

Habrocythere fragilis Triebel, 1940

(pl.29,figs.6,7,9,10,11)

1940 Habrocythere fragilis Triebel;166,pl.9,fig.101;pl.10,figs.10-13

1956 Habrocythere fragilis Triebel;Mertens:198,pl.10,figs.51,52

1963c Habrocythere fragilis Triebel;Kaye:33,pl.3,figs.8,9

1965c Habrocythere fragilis Triebel;Kaye:229,pl.6,figs.7-13

1966 Habrocythere fragilis Triebel;Gründel:21,pl.3,fig.5

1971b Habrocythere fragilis Triebel;Damotte:114,pl.8,fig.9

Diagnosis: A small, subovate, species of Habrocythere with a prominent low,rounded eye tubercule and a strongly pitted lateral surface.

|     |                        | Length   | Height | Width |
|-----|------------------------|----------|--------|-------|
| 390 | R.V. Male              | 0.42m.m. | 0.21   | 0.11  |
| 391 | Dorsal, Male, Carapace | 0.51     | 0.29   |       |
| 392 | L.V. Female            | 0.43     | 0.27   | 0.12  |

|     |             |      |      |      |
|-----|-------------|------|------|------|
| 393 | L.V. Female | 0.43 | 0.27 | 0.12 |
| 394 | R.V. Female | 0.41 | 0.21 | 0.10 |

Description: A small species which is subovate in lateral view and has a strongly pitted surface. The dorsal margin is weakly arched and the anterior margin is strongly curved; posterior margin is also strongly curved, more narrowly so than the anterior margin. The ventral margin is weakly concave, straight. The valves are weakly compressed. The marginal area is broad and compressed forming a narrow sloping shelf around the entire margin. The ventral tumidity partially overhangs the ventral margin, posteriorly to this a slight hollow is present. The antero-dorsal margin is notched. The eye tubercle is prominent, low, and rounded. Marginal denticulation may be present along the antero-ventral and posterior margins. In dorsal view the valve is weakly arched. Sexual dimorphism is strong and males are more elongate and less high than females.

Remarks: This species was first described by Triebel (1940) from the N.minimus Zone of northwestern Germany. Gründel (1966) recorded it from the Middle Albian to Lower Cenomanian, which is similar to its recorded range in England. Weaver (MS.) recorded it as rare throughout the Cenomanian of southern England and Damotte (1971b) recorded it from the H.dentatus and M.inflatum Zones of the Paris Basin.

Kaye (1965c) described many specimens, which although otherwise identical, have large eye spots mounted on a large tubercle. These, as Kaye noted, are similar in appearance to species of the genus Euryitycythere Oertli, 1959 and may indicate an origin for this species. Kaye recorded this variety mainly in the A.daviesi and D.cristatum Subzones. Similar specimens were not recorded in the present study.

Stratigraphic conclusion: This species first occurs in the H.dentatus Zone and ranges through into the Cenomanian. It is of

moderate stratigraphic value.

Genus Eucythere Brady, 1868

Type species: Cythere declivis Norman, 1865

Eucythere trigonalis (Jones & Hinde, 1890)

(pl.30,figs.1-3,6.)

1890 Pontocypris trigonalis Jones & Hinde;3,pl.3,figs.25,26;pl.4,  
figs.1,2

1893 Pontocypris trigonalis Jones & Hinde;Chapman & Sherborn:346

1940 Eucythere trigonalis (Jones & Hinde);Triebe1:164,pl.1,figs.4-9;  
pl.9,fig.100

1956 Eucythere trigonalis (Jones & Hinde);Mertens:199,pl.11,figs.  
56-58

1962 Eucythere trigonalis (Jones & Hinde);Ellermann:398,figs.8a,b,9

1963c Eucythere trigonalis (Jones & Hinde);Kaye:29,pl.1,fig.1

1966 Eucythere trigonalis (Jones & Hinde);Gründel:23,pl.3,fig.27

1978 Eucythere trigonalis (Jones & Hinde);Neale:pl.1,fig.10

Diagnosis: A small, smooth, elongate, species of Eucythere  
with a straight ventral margin.

|     |               | Length   | Height | Width |
|-----|---------------|----------|--------|-------|
| 395 | L.V. Male     | 0.56m.m. | 0.27   |       |
| 396 | L.V. Female   | 0.51     | 0.29   | 0.11  |
| 397 | R.V. Female   | 0.53     | 0.29   | 0.11  |
| 398 | Dorsal Female | C.0.50   |        | 0.22  |

Description: A small species which has a smooth lateral surface.  
The greatest height is at one third length and the greatest width  
occurs at two thirds length. In lateral view the dorsal margin is  
weakly curved, the posterior margin is narrowly rounded and the  
ventral margin is straight, or weakly concave, with a small

indentation at one third length. The dorsal and ventral margins weakly converge posteriorly giving a sub-triangular appearance to the valve. The valves appear gently arched in dorsal view.

Remarks: This species was originally described from the Gault Clay of Folkestone. Subsequently it has been described from the Middle and Upper Albian of northwestern Germany. It has not been recorded from the Paris Basin. Kaye (1963c) recorded it from the Middle Albian of Speeton.

This species is very similar to E.solitaria Triebel, 1940 from which it differs in being much longer and higher in proportion to its length. All the German authors recorded these two species co-existing. E.solitaria has not been recorded from southern England.

Stratigraphic conclusion: This species occurs in the Middle and Upper Albian of the Southern North Sea and German basins. It first appears in southern England at the base of the D.cristatum Subzone. It has not been recorded from the Paris Basin. It is of local stratigraphic value.

Subfamily CYTHERURINAE Van Morkhoven, 1962

Genus Cytherura Sars, 1866

Type species: Cythere gibba O.F.Müller, 1785

Cytherura striatoides Bonnema, 1941

(pl.31,fig.1)

1941 Cytherura striatoides Bonnema:10,pl.5,figs.24-28

1966 Cytherura striatoides Bonnema;Herrig:864,pl.28,figs.18-21

Diagnosis: An elongate species of Cytherura with straight dorsal and ventral margins which converge towards the posterior.

Lateral surface bears a number of prominent longitudinal ribs.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 434 | L.V. Female | 0.37m.m. | 0.18   | 0.07  |

Description: A thinly calcified, elongate species. The dorsal and ventral margins are straight and converge towards the sub-triangular posterior margin. The anterior margin is obliquely rounded. The lateral surface is poorly inflated and bears nine prominent longitudinal ribs.

Remarks: This species was recorded by Weaver (MS.) as rare throughout the Cenomanian of southern England. In the present study only one specimen was recorded from the topmost S.dispar Zone.

Stratigraphic conclusion: This species only occurs very rarely in the topmost Albian and is of limited stratigraphic value.

Genus Hemicytherura Elofson, 1941

Type species: Cythere cellulosa Norman, 1865

Hemicytherura euglyphea Kaye, 1965

(pl.28,figs.12,15,18)

1965c Hemicytherura euglyphea Kaye:231,pl.8,figs.1-4

1978 Hemicytherura euglyphea Kaye;Neale:pl.3,fig.6

Diagnosis: A species of Hemicytherura with strong longitudinal ribs.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 458 | R.V. Female      | 0.33m.m. | 0.17   | 0.09  |
| 459 | R.V. Female      | 0.37     | 0.18   | 0.08  |
| 460 | Dorsal Female C. | 0.32     | 0.18   | 0.08  |

Description: An elongate, subovate species of Hemicytherura which has a broadly curved dorsal margin which lacks cardinal angles. The anterior margin is sharply rounded. The ventral margin is sinuous, mostly straight, but slightly concave at one third length;



the postero-ventral margin is short and straight; posterior margin drawn out into a short blunt caudal process which occurs just above mid-height. Laterally this species is compressed, greatest height and width at mid-length. The lateral surface is strongly ornamented and is covered by a number of strong longitudinal ribs which have short diagonal ribs. The ventro-lateral tumidity obscures part of the ventral margin. The eye spot is prominent and glassy. No vestibulae. Hinge weak but complex with two faintly denticulate terminal teeth in the right valve; between these a median, marginal bar is present. Sexual dimorphism is well marked.

Remarks: This distinctive small species was defined by Kaye (1965c) from the H. orbignyi Subzone, Wrotham, Kent. He recorded it as rare in the upper part of the Lower Gault, but more common in the Upper Gault. This species has only been recorded from the Gault Clay of Southern England.

Stratigraphic conclusion: A sporadically occurring species which first occurs in the H. spathi Subzone and ranges through to the Cenomanian. It is of moderate local stratigraphic value.

Genus Eucytherura Müller, 1894

Type species: Cythere complexa Brady, 1867

Eucytherura gründeli Weaver MS.

(pl.31, fig.13)

1966 Eucytherura (Vesticytherura)? tumidis? Bonnema; Gründel:43, pl.7,  
figs.37,38

Diagnosis: A strongly pitted species of Eucytherura with a node in the area of the muscle scars and a weak median sulcus.

|                  | Length   | Height | Width |
|------------------|----------|--------|-------|
| 404a L.V. Female | 0.31m.m. | 0.15   | 0.11  |

Description: A small sub-quadrate, inflated, strongly pitted species with a straight dorsal margin and a weakly convex ventral margin. These margins converge weakly towards the posterior. The anterior margin is broadly curved and the posterior margin is sub-triangular. Greatest height at one sixth length, greatest width at one half length. The lateral surface is inflated and irregularly ornamented and is mostly covered by a coarse pitting. A weak median sulcus is present and small irregular nodes are present on either side of the mid-point of the valve. The ventral surface is steep and overhangs, partly obscuring, the ventral margin. The dorsal surface also partly obscures the dorsal margin. The ventral surface bears two narrow longitudinal ridges at about one half length. The lateral surface bears a number of short spines.

Remarks: This species was first recognised as a distinct species by Weaver (MS.) who recorded it from the Cenomanian of southern England. He named it after Gründel who first figured it but assigned it to a species described by Bonnema (1940). Gründel (1966) recorded it from the Middle and Upper Albian of Germany.

Stratigraphic conclusion: In southern England this species first appears in the S.dispar Zone and ranges into the Cenomanian. It first appears in the Middle Albian of Germany and is of moderate local stratigraphic significance.

Eucytherura kayei Weaver MS.

(pl.31, fig.19.)

Diagnosis: An elongate species of Eucytherura which bears four inflated nodes along the dorso-lateral margin and three along the ventro-lateral margin.

|                 | Length    | Height | Width |
|-----------------|-----------|--------|-------|
| 405 L.V. Female | 0.34 m.m. | 0.15   | 0.12  |

Description: An elongate, inflated species with straight dorsal and ventral margins which converge towards the bluntly rounded posterior margin. The anterior margin is broadly rounded. The lateral surface is inflated, finely pustulose, and bears seven prominent inflated nodes which are arranged in two rows. One row consisting of four nodes is inset from the dorsal margin. This row weakly diverges from the margin anteriorly, the dorsal two nodes of this partly obscure the dorsal margin. The ventral row of three tubercles diverges slightly from the ventral margin towards the anterior. The nodes occur from three quarters to one quarter length; the posterior node of this row is the largest. The lateral surface is coarsely pitted and bears weak reticulation which is strongest near the anterior and posterior margins.

Remarks: This species was first recognised by Kaye (1965c) who included it in E.aff.E.(E.)nuda. It was recognised as a distinct species by Weaver (MS.) who recorded it from throughout the Cenomanian of southern England. He noted that it always occurs rarely. Many of the Albian specimens differ from the typical Cenomanian forms in having reticulation, which in the younger specimens has been completely replaced by a dense series of pustules. This species can easily be distinguished from E.sp.aff.E.nuda by the presence of two postero-ventral nodes and the bulbous dorsal nodes.

Stratigraphic significance: This species first appears in the S.dispar Zone of southern England and ranges through into the Cenomanian. It is of moderate local stratigraphic value.

Eucytherura longisculpta Weaver MS.

(pl.32,figs.8,10.)

Diagnosis: A species of Eucytherura with a weak dorsal rib and a weak muscle node. Valves inflated; surface strongly reticulate.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 422 | Dorsal Female C. | 0.28m.m. |        | 0.15  |
| 423 | L.V. Female C.   | 0.30     | 0.17   | 0.14  |

Description: A small, sub-rectangular species with straight dorsal and ventral margins; dorsal margin strongly rounded; postero-dorsal and postero-ventral margins are weakly convex and meet at a bluntly pointed posterior extremity just above mid-height. The lateral surface is inflated and strongly reticulate. Three weak, narrow, longitudinal ribs extend the length of the ventral inflation. The anterior and posterior margins are laterally compressed.

Remarks: This species is similar to that described by Weaver (MS.) from the Middle and Upper Cenomanian of southern England. In the present study this species was only recorded very rarely from the topmost S.dispar Zone.

Stratigraphic conclusion: A rare species of limited stratigraphic value.

#### Eucytherura multituberculata Gründel, 1964

(pl.31,figs.11,15,16)

1964b Eucytherura multituberculata Gründel:748,pl.2,figs.12,13

1964a Eucytherura ansata Weingeist;Kaye:97,pl.4,figs.1-4

1966 Eucytherura multituberculata Gründel;Gründel:42,pl.7,figs.28,29

1978 Eucytherura ansata Weingeist;Neale:pl.3,fig.1

Diagnosis: A small species of Eucytherura with a straight dorsal margin which has four prominent nodes slightly inset from it and partially obscuring it.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 406 | R.V. Female | 0.25m.m. | 0.14   | 0.06  |

|     |             |      |      |      |
|-----|-------------|------|------|------|
| 407 | L.V. Female | 0.25 | 0.14 | 0.06 |
| 408 | R.V. Female | 0.26 | 0.15 |      |

Description: A small species which is sub-rectangular in outline and has a straight dorsal margin with two weak hinge ears at either end. The anterior margin is weakly curved; ventral margin weakly curved; posterior margin obliquely truncated. The greatest height occurs at one sixth length. Four strong marginal denticles are present antero-ventrally. The lateral surface is flat, but four prominent rounded nodes are present in a line parallel to, and slightly inset from, the dorsal margin. A notched node is present at the postero-ventral margin which is partially obscured in lateral view. The lateral surface is covered by a small number of large pits. A small shelf is present along the posterior margin. The right valve has a sub-triangular posterior margin.

Remarks: This species was first described by Gründel (1964) from the Albian of East Germany. He recorded it commonly throughout the Middle and Upper Albian and showed that it differs from E.ansata in having a double postero-ventral node and in lacking lateral, raised, pore cones. Weaver (MS.) recorded it throughout the Cenomanian of Southern England.

Stratigraphic conclusion: This species first occurs in the H. dentatus Zone of the Anglo-Paris Basin. It has also been recorded from the Middle Albian of Germany. It ranges through into the Cenomanian and is of moderate stratigraphic value.

Eucytherura sp.aff.E.nuda Kaye, 1964

(pl.31,figs.17,18)

1965c Eucytherura aff.nuda Kaye:231,pl.7,figs.17,18

Diagnosis: A species of Eucytherura with a prominent postero-ventral inflation, weak reticulation, and a strongly pitted surface.

|     |             | Length   | Height |
|-----|-------------|----------|--------|
| 469 | L.V. Female | 0.39m.m. | 0.18   |
| 470 | R.V. Female | 0.39     | 0.17   |

Description: A small, weakly calcified species with long, straight dorsal and ventral margins which weakly converge posteriorly. The anterior margin is broadly rounded; postero-ventral margin rounded, the postero-dorsal margin is straight and meets the dorsal margin in a prominent cardinal angle. The posterior and anterior lateral areas are weakly inflated. A weak depression is present at the mid dorso-ventral surface and extends toward the prominent postero-ventral lobe. The ventro-lateral surface obscures the ventral margin in lateral view. The lateral surface is covered by a weak reticulation and is densely pitted. The greatest height occurs at one sixth length, width at three quarters length.

Remarks: This species was first recorded by Kaye (1965c) from the H.orbignyi Subzone of Wrotham, Kent. He noted the similarity to E.nuda Kaye, 1964 and remarked that this Albian species differed by having a more strongly inflated postero-ventral lobe and stronger surface reticulation. E.nuda was recorded by Kaye from the Barremian. Kaye, in his description of this species, also noted that one specimen from the Lower Gault had two rows of surface nodes. This specimen should more correctly be assigned to E.kayei. In the present study E.sp.aff.E.nuda was only recorded from the S.dispar zone of southern England.

Stratigraphic conclusion: This species was recorded sporadically from the Upper Albian of southern England. It is of limited stratigraphic value.

Eucytherura sp.A. sp.nov.

(pl.31, figs. 5, 7-9)

Diagnosis: A small species of Eucytherura with three irregularly pointed nodes slightly inset from the dorsal margin. The posterior two nodes partially obscure the margin.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 410 | L.V. Female      | 0.34m.m. | 0.18   | 0.09  |
| 411 | Dorsal Female C. | 0.32     |        | 0.16  |
| 412 | R.V. Female      | 0.34     | 0.17   | 0.09  |
| 413 | R.V. Female      | 0.37     | 0.19   |       |

Description: A small coarsely ornamented species with a straight dorsal margin. Weak hinge ears are present at either end of this margin. The anterior margin is weakly curved; ventral margin weakly curved; posterior margin bluntly truncated, irregular in shape with notches both postero-dorsally and postero-ventrally. The lateral surface is dominated by a strong median sulcus which extends to the dorsal margin. Along the dorsal margin are three irregularly spined nodes which are all slightly inset from the dorsal margin. One of these is situated anteriorly of the median sulcus; the two situated posteriorly of this are larger, more spinose, and partially obscure the dorsal margin. Two other small nodes are present on the lateral surface inset from the antero-ventral and postero-ventral margins. Along the posterior and anterior marginal areas weak shelves are present. The lateral surface is coarsely ornamented. The greatest height occurs at one sixth length.

Remarks: This species shows some similarity to E.costata Gründel which Gründel (1966) first recorded from the Hauterivian.

Stratigraphic conclusion: This species has only been recorded from the Upper Albian of southern England. It occurred most abundantly in the S.dispar Zone and is of moderate local stratigraphic value.

Genus Orthonotacythere Alexander, 1934

Type species: Cytheridea? hannai Israelsky, 1929

Orthonotacythere fordensis Kaye, 1965

(pl.31,figs.4,6.)

1965c Orthonotacythere fordensis Kaye:237,pl.5,figs.7-13

Diagnosis: A species of Orthonotacythere with weak reticulation, strong pitting, and a prominent, deep, median sulcus.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 415 | R.V. Female | 0.45m.m. | 0.24   | 0.12  |

Description: This species has a straight dorsal margin, a broadly rounded anterior margin, and a weakly convex ventral margin that curves more strongly postero-ventrally and joins the bluntly truncated posterior extremity at three quarters height. The lateral surface is irregularly inflated with a deep, wide, median sulcus that extends to the dorsal margin. Two inflated nodes occur slightly inset from the dorsal margin on either side of the median sulcus; the anterior node partially obscures the dorsal margin. The lateral surface is covered by a series of coarse pits and irregular riblets which form a weak reticulation.

Remarks: This species was first described by Kaye (1965c) from the A.intermedius Subzone of Wrotham, Kent. Both the holotype and paratypes were collected from this locality and horizon. Kaye remarked that this species occurs fairly commonly in that Subzone and appears to be restricted to it. Kaye also discussed the origin of this species and noted its close relationship with the two Aptian species, O.catalaunica Damotte & Grosdidier, and O.typica Kaye. He noted the difference between the evolution of this species in the southern North Sea and in the Anglo-Paris Basin.

Stratigraphic conclusion: This species was first recorded



occurring in the H.dentatus Zone of southern England where it ranges through to the H.varicosum Subzone. It occurs sporadically and is of moderate stratigraphic value.

Genus Pseudobythocythere Mertens, 1956

Type species: Pseudobythocythere goerlichii Mertens, 1956

Pseudobythocythere goerlichii Mertens, 1956

(pl.31,fig.14)

1956 Pseudobythocythere goerlichii Mertens:201,pl.11,figs.62-65;pl.13,figs.94-96

1965a Pseudobythocythere goerlichii Mertens;Kaye:76,pl.5,figs.10,11

1966 Pseudobythocythere goerlichii Mertens;Gründel:49,pl.8,fig.34

1978 Pseudobythocythere goerlichii Mertens;Neale:pl.5,figs.11,12

Diagnosis: An alate species of the genus Pseudobythocythere which has a weak central median sulcus.

|                 | Length | Height |
|-----------------|--------|--------|
| 416 L.V. Female | 0.42   | 0.27   |

Description: Analate species of Pseudobythocythere with a weak median sulcus which divides the lateral surface vertically into two halves. The left valve has a sinuous dorsal margin and a broadly rounded anterior margin with sinuous ventral and bluntly pointed posterior margins. The right valve has a straighter dorsal margin which has a postero-dorsal notch. A narrow shelf extends along the anterior margin. The lateral surface is dominated by the dorsally concave, sinuous, ventro-lateral rib which extends four fifths the length of the valve to the anterior margin just below maximum height. This rib is strong and alate and overhangs the ventral surface. The ventral surface bears a narrow longitudinal rib which extends its length. A short narrow antero-dorsal marginal rib is also present.

The lateral surface is smooth. Some specimens have two short dorsally convex ribs either side of the mid-point. The greatest height occurs at mid-length.

Remarks: This distinctive species was described from northwest Germany by Mertens (1956) who gave the type horizon as Lower Albian. He also recorded it from the Aptian. Kaye (MS.) recorded it from just below the Greensand Streak at Speeton. He also stated that at Speeton it is limited to the Lower Albian. Gründel (1966) recorded it from the Lower Albian of Germany and Neale (1978) described it as diagnostic of the Lower Albian. In the present study it was only recorded in the basal samples of borehole 49/19-1. This probably indicates the presence of Lower Albian clays below the Red Chalk in this borehole.

Stratigraphic conclusion: This rare species appears to be restricted to the Aptian and Lower Albian of the southern North Sea and German basins. It is of moderate stratigraphic value.

Genus Hemiparacytheridea Herrig, 1963

Type species: Paracytheridea (Hemiparacytheridea) occulta Herrig, 1963

Hemiparacytheridea minutissima (Kaye, 1965)

(pl.31, fig.12)

1965c Orthonotacythere minutissima Kaye:239, pl.8, figs.5-11

Diagnosis: A small species of Hemiparacytheridea with a ventral alate longitudinal rib and a prominent eye tubercule.

|      |             | Length   | Height | Width |
|------|-------------|----------|--------|-------|
| 465a | R.V. Female | 0.33m.m. | 0.17   | 0.12  |
| 465b | R.V. Female | 0.34     | 0.19   |       |

Description: Valves very small, elongate, laterally compressed. The dorsal margin is long and straight; the dorsal half of the

ventral margin is straight, posterior half convex to the elongated postero-dorsal caudal process. The eye tubercle is very strongly developed. The dorsal margin is weakly concave with a strong antero-dorsal cardinal angle; antero-ventral margin strongly curved. The lateral surface is dominated by the ventral longitudinal rib which is alate postero-ventrally where it obscures part of the ventral margin. A weak median sulcus is present; an extension of this divides the longitudinal rib into two prominent nodes which are connected by a narrow rib. The postero-dorsal marginal area bears an angular node which in lateral view partly obscures the dorsal margin. The valve surface is pitted. The anterior margin bears four or five denticules. The hinge in the left valve consists of a long straight denticulate bar.

Remarks: Kaye (1965c) originally described this species from the H.varicosum Subzone of Wrotham, Kent. He recorded it as rare in the Upper Gault. Kaye placed this species in the genus Orthonotacythere but Neale (1978) placed it in the above genus, and this was followed by Weaver (MS.). Weaver recorded it as fairly common in the Lower Cenomanian of southern England. In the present study it was recorded fairly commonly in the S.dispar Zone and rarely in the C.auritus and H.varicosum Subzones.

Stratigraphic significance: A rare species that occurs most abundantly in the S.dispar Zone and the Lower Cenomanian of southern England.

Genus Cytheropteron Sars, 1866

Subgenus Cytheropteron (Cytheropteron) Alexander, 1933

Type species: Cythere latissima Norman, 1865

Cytheropteron (Cytheropteron) arguta Kaye, 1965

(pl.32, figs.15-17)

1965c Cytheropteron (Cytheropteron) arguta Kaye:232, pl.8, figs.12-17

Diagnosis: A species of Cytheropteron with a strongly reticulate lateral surface and a strongly ridged, posteriorly directed, alae.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 417 | L.V. Female | 0.45m.m. | 0.32   | 0.17  |
| 418 | L.V. Female | 0.40     | 0.25   | 0.13  |
| 419 | R.V. Female | 0.40     | 0.23   | 0.12  |

Description: This ovate species is strongly ornamented. It has a broadly curved dorsal margin with no cardinal angles. The dorsal margin is bluntly rounded and the ventral margin is very weakly convex; posterior margin bluntly triangular formed from a short caudal process. The greatest height and width occur at mid-length. Valves inflated with a prominent ventro-lateral alae which is posteriorly directed and has a strong ridge running along its greatest width from the ventro-lateral extremity, parallel to the ventral margin, to two thirds the valve length. This alae obscures the ventral margin which it overhangs; ventral surface concave. Lateral surface strongly reticulate; ventral surface weakly striated. Hinge strong with long terminal sockets and coarsely crenulate bar in the left valve.

Variation: This species is larger and less strongly reticulate in the S.dispar Zone.

Remarks: This distinctive species was first described by Kaye (1965c) from the H.orbigny Subzone of Wrotham, Kent. Kaye recorded it as abundant in the H.orbigny Subzone of Wrotham, Henfield and Pinhay. He regarded it as an index species. In the present study this species was first recorded in the H.orbigny Subzone, it ranges into the high S.dispar Zone.

Stratigraphic significance: This species has only been recorded from the Upper Albian of southern England where it is of

moderate stratigraphic significance.

Cytheropteron (Cytheropteron) fenestrata Kaye, 1965

(pl.32,fig.5)

1965c Cytheropteron (Cytheropteron) nanissimum fenestrata

Kaye:234,pl.7,figs.14,16,19

Diagnosis: A species of Cytheropteron with a strong rib parallel to the ventral margin on the lateral surface of the alae.

|     |             | Length   | Height |
|-----|-------------|----------|--------|
| 427 | R.V. Female | 0.29m.m. | 0.16   |

Description: A small species, subovate in outline, with a strong ventro-lateral alae. The dorsal and ventral margins are convex and the anterior margin is bluntly rounded. A weak postero-dorsal cardinal angle is present and a weak marginal shelf extends along the dorsal margin. The lateral surface is dominated by a posteriorly directed alae. A strong ridge extends along the ventral margin of the alae and partially obscures the ventral margin of the valve. Two dorsally directed grooves on the lateral surface of the alae are crossed by a short bar giving a fenestrate ornamentation. The lateral surface is smooth.

Remarks: This species was first described by Kaye (1965) from the Anglo-Paris Basin. It was originally regarded as a chronosubspecies of Cytheropteron (C.)nanissimum from which it differs in having fenestrate ornamentation. Damotte (1971b) thought it could possibly be assigned species status but lacked the evidence to be certain. In the present study only one specimen was found from the A.intermedius Subzone and since C.(C.)nanissimum occurs earlier in the H.spathi Subzone it is unlikely that they are chronosubspecies.

Kaye (1965c) only recorded this species from the H.spathi Subzone of southern England.

Stratigraphic conclusion: This species has only been recorded rarely from the H.dentatus Zone and the A.intermedius Subzone of the Anglo-Paris Basin. It is of moderate, local, stratigraphic value.

Cytheropteron (Cytheropteron) milbournei Kaye, 1965

(pl.32,figs.2,3)

1965c Cytheropteron (Cytheropteron) milbournei Kaye:233,pl.7,figs.

4,6,7

Diagnosis: A species of Cytheropteron which is strongly pitted and has a sharply pointed postero-lateral alae.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 420 | R.V. Female | 0.33m.m. | 0.14   | 0.12  |
| 421 | L.V. Female | 0.30     | 0.19   | 0.15  |

Description: Valves small, weakly calcified, and sub-ovate with a prominent ventro-lateral alae. The dorsal margin is straight and the anterior margin is rounded; ventral margin sinuous, slightly concave at one third length; posterior margin bluntly triangular, formed from a short caudal process slightly above mid-height; dorsal margin lacks an anterior cardinal angle. A weak postero-dorsal angle is present. Marginal denticulation weakly developed antero-ventrally. The lateral surface is inflated and is extended to form a postero-ventral, pointed, alae. This alae overhangs part of the ventral margin; a ridge is present along its anterior margin and the lateral surface bears a prominent groove. The ridge is inflated to a small node at its base. Most of the lateral surface is covered by large pits. The anterior and posterior marginal areas bear strong

reticulation. The hinge is merodont.

Variation: The inflation of the node at the anterior end of the alae is variable in both size and shape.

Remarks: This distinctive species was first described by Kaye (1965c) from the M.subdelaruei Subzone of southern England. The holotype and paratypes were collected from the Middle Albian of Sevenoaks, Kent. He recorded it rarely from the topmost Lower Gault of the Sevenoaks area and stated that the whole lateral surface is covered by a series of pits. In the present study this species was also recorded in the S.dispar Zone where specimens were more strongly reticulate than those in the Middle Albian.

Stratigraphic conclusion: This species has been recorded from the E.loricatus, E.lautus and S.dispar Zones in southern England where it is of moderate stratigraphic significance.

Cytheropteron (Cytheropteron) nanissimum

Damotte & Grosdidier, 1963

(pl.32,figs.1,4,7,9)

1963 Cytheropteron nanissimum Damotte & Grosdidier:56,pl.1,figs.2a-f

1965c Cytheropteron (Cytheropteron) nanissimum nanissimum Damotte & Grosdidier;Kaye:234,pl.7,figs.13,15

1966 Cytheropteron (Cytheropteron) nanissimum Damotte & Grosdidier; Gründel:46,pl.8,figs.27,28

1971b Cytheropteron nanissimum Damotte & Grosdidier;Damotte:117,pl.8, fig.17

Diagnosis: A small species of Cytheropteron which has two prominent grooves on the lateral surface of the alae.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 424 | R.V. Female | 0.30m.m. | 0.17   | 0.10  |

|     |                  |      |      |
|-----|------------------|------|------|
| 425 | Dorsal Female C. | 0.30 | 0.18 |
| 426 | L.V. Female      | 0.26 | 0.16 |

Description: A small, strongly calcified species, with a broadly curved margin; anterior margin bluntly curved; ventral margin sinuous; posterior margin sharply rounded, formed of a short caudal process at mid-height. A narrow marginal shelf is present along the dorsal margin. The lateral surface is extended into a strong alae which overhangs and obscures half the ventral margin. A strong ventro-lateral ridge extends in a posterior direction from the antero-ventral valve extremity where it is very weak, to the posterior extremity of the alae, where it is stronger. On the lateral surface of the alae two strong grooves and three prominent ribs extend towards the dorsal margin.

Remarks: This species was first described from the M.inflatum Zone of the Paris Basin by Damotte and Grosdidier (1963). Subsequently, Gründel (1966) has described it from the Middle and Upper Albian of Germany and Kaye (1965c) recorded it first appearing in the D.niobe Subzone of southern England and ranging into the Upper Albian. Weaver (MS.) recorded it from throughout the Cenomanian of southern England and remarked that the Cenomanian specimens often have a lesser relief to the dorsal and ventral ribs than the Albian specimens.

Stratigraphic conclusion: This species first appears in the H.spathi of the Anglo-Paris Basin and ranges through into the Cenomanian. It occurs fairly commonly and is of moderate stratigraphic value.

Subgenus Eocytheropteron Alexander, 1933

Type Species: Cytheropteron bilobatum Alexander, 1933



Cytheropteron (Eocytheropteron) protonsa Kaye, 1965

(pl.32,figs.11,13,14)

1965c Cytheropteron (Eocytheropteron) protonsa Kaye:235,pl.6,figs.1-6

Diagnosis: A large species of Cytheropteron with a bilobed, wing-like, alae and a prominent up turned caudal process.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 428 | R.V. Female | 0.58m.m. | 0.34   | 0.35  |
| 429 | L.V. Female | 0.63     | 0.35   | 0.32  |

Description: This large elongate species has a strongly developed wing-like alae. The dorsal margin is broadly curved with no cardinal angles, in the right valve dorsal margin straight; anterior margin broadly rounded; ventral margin weakly convex; posterior margin elongated and formed of an upturned caudal process; postero-ventral margin straight. A bilobate alae dominates the lateral surface, the posterior of the lobes is more extended. Poorly developed riblets are present on the postero-lateral surface. From the depression of the two lobes a depression runs across the mid-lateral surface to the dorsal margin. The ventral surface bears a number of longitudinal ribs.

The hinge is formed of two long, low, strongly crenulate teeth which are separated by a smooth median element.

Variation: Single lobed specimens have been recorded in the same population as bilobed specimens. This may be a reflection of sexual dimorphism.

Remarks: This distinctive species was first described by Kaye (1965c) from the D.cristatum Subzone of southern England. Kaye first recorded this species with a bilobed alae. In the present study this species was only recorded from the M.inflatum Zone of southern England.

Stratigraphic conclusion: A rare species of limited stratigraphic importance.

Subgenus Cytheropteron (Infracytheropteron) Kaye, 1964

Type species: Cytheropteron (Infracytheropteron) exquisita Kaye, 1964

Cytheropteron? (Infracytheropteron) obscura Kaye, 1964

(pl.32,fig.12)

1965c Cytheropteron? (Infracytheropteron) obscura Kaye:236,pl.7,figs.

10-12

Diagnosis: An ovate species of Cytheropteron ? with a smooth lateral surface and a rounded ventro-lateral tumidity.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 431 | L.V. Female | 0.41m.m. | 0.26   | 0.18  |

Description: Valves small, ovate, with a smooth lateral surface. Ventro-lateral tumidity rounded. The dorsal margin is strongly arched and lacks cardinal angles; anterior margin rounded; ventral margin short and straight; posterior margin has a short blunt caudal process just above mid-height. A flat marginal shelf is present anteriorly, posteriorly, and postero-ventrally. A low, smooth, eye tubercle is present.

Remarks: This species has only previously been recorded by Kaye (1965c). He recorded it from the D.cristatum Subzone, Wrotham, Kent. Both holotype and paratypes were collected from this horizon. Only two specimens were recorded in the present study; one of these was collected from the base of the M.inflatum Zone and the other from the top of this Zone.

Stratigraphic conclusion: A rare species that has only been recorded from the M.inflatum Zone of southern England. It is of

limited stratigraphic importance.

Genus Pedicythere Eager, 1965

Type species: Pedicythere tessae Eager, 1965

Pedicythere sp.A.sp.nov.

(pl.30,figs.13,14)

Diagnosis: A small species of Pedicythere with a long, pointed, alate extension.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 463 | L.V. Female | 0.33m.m. | 0.17   | 0.17  |
| 464 | L.V. Female | 0.34     | 0.20   | 0.21  |

Remarks: This species has only been recorded very rarely from the Upper Albian. Most of the recorded specimens were broken. Weaver (MS.) recorded Pedicythere pitstonensis n.sp. from the Cenomanian of southern England. Albian specimens are probably early forms of this.

Subfamily LOXOCONCHINAE Van Morkhoven, 1962

Genus Loxoconcha Sars, 1866

Type species: Cythere impressa Baird, 1850

Loxoconcha? icknieldensis Weaver MS.

(pl.33,figs.1-5,7)

Diagnosis: A species referred to the genus Loxoconcha with a concentrically pitted surface and lophodont hinge.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 435 | L.V. Male   | 0.47m.m. | 0.29   | 0.14  |
| 436 | L.V. Female | 0.44     | 0.30   |       |
| 437 | L.V. Female | 0.41     | 0.25   | 0.12  |

|     |           |      |      |      |
|-----|-----------|------|------|------|
| 438 | R.V. Male | 0.51 | 0.26 | 0.12 |
| 439 | L.V. Male | 0.47 | 0.29 | 0.14 |

Description: A small, inflated species with sub-parallel, sinuous, margins. Dorsal margin weakly sinuous, straight, slightly upturned posteriorly; ventral margin gently curving upwards at the posterior; posterior margin broadly rounded, posterior extremity is at two-thirds height; anterior margin broadly rounded. The lateral surface is strongly inflated and is covered by concentrically arranged pits and riblets. The ventral inflation partially obscures the ventral margin. In dorsal view the sides of the valves are straight, they converge slightly towards the posterior. The greatest height occurs at mid-length and the greatest width at three quarters length. Males are longer and less high than females. Juveniles are strongly calcified.

The inner lamellae is moderately wide at both the anterior and posterior ends with narrow anterior and postero-ventral vestibules. There are ten straight pore canals anteriorly and four posteriorly. The hinge is simple in the right valve and it consists of two small, simple, terminal teeth separated by a smooth bar. Muscle scars consist of a row of four oval scars with a 'v' shaped antennal scar.

Remarks: This species was first described by Weaver (MS.) from the Cenomanian of southern England. Albian specimens are similar to the Cenomanian forms but are less strongly pitted. They have a weakly developed hinge which is clearly not gongylodont and can, therefore, only be tentatively assigned to the genus Loxoconcha. Weaver (MS.) recorded this species from the Lower Cenomanian of southern England. In the present study it was recorded sporadically from the S.dispar Zone of southern England.

Stratigraphic conclusion: This species has only been recorded from the S.dispar Zone and Lower Cenomanian of southern England where

it is of moderate stratigraphic significance.

Subfamily BYTHOCYTHERINAE Van Morkhoven, 1962

Genus Monoceratina Roth, 1928

Type species: Monoceratina ventrale Roth, 1928

The generic position of this mid-Cretaceous species which is allied to M.umbonata (Williamson) is uncertain. Van Morkhoven (1962) questioned the assignment of post Palaeozoic species to this genus which was defined from the Palaeozoic. Gründel & Kozur (1973) reviewed this problem and preferred the genus Bythoceratina. They split this into several sub-genera and defined closely related genera. This taxonomic situation was followed by Neale (1978).

Moore (1961, Treatise) described the genus Bythoceratina Hornibrook, 1952 as differing from Monoceratina in having a long denticulate median element to an otherwise lophodont hinge. All the Albian species have smooth median elements and are thus retained in the genus Monoceratina.

Monoceratina bonnemaï Kaye, 1964

(pl.33,fig.8)

1964c Monoceratina bonnemaï Kaye:52,pl.3,fig.2

Diagnosis: A species of Monoceratina which has a smooth lateral surface which bears a prominent bulbous tubercle in the anterior half of the dorso-lateral surface.

|                      | Length   | Height | Width |
|----------------------|----------|--------|-------|
| 443 Carapace, Female | 0.69m.m. | 0.31   | 0.21  |

Description: Valves elongated with straight, parallel, dorsal and ventral margins. The posterior margin is drawn out into a blunt

caudal process postero-dorsally. A median sulcus divides the lateral surface; ventrally there are two prominent spines which are partially fused at their base and limit the sulcus ventrally. A large bulbous node occurs on the dorsal part of the antero-lateral surface. The anterior margin is gently rounded with a distinct antero-dorsal cardinal angle; the postero-ventral margin is gently curved.

The hinge is adont with a simple bar in the left valve fitting into a groove in the right valve.

Remarks: This species was first described by Kaye (1964c) from the Cambridge Greensand. It was subsequently recorded by Weaver (MS.) from the 'Glaucinitic Marl' of southern England. In the present study it was only recorded from the 'Glaucinitic Marl' (Cenomanian) of Copt Point.

Stratigraphic significance: This species appears to be limited in distribution to the basal Cenomanian Greensand of southern England. This is an important index species.

Monoceratina sp.cf.M.longispina (Bosquet, 1854)

(pl.33,fig.10)

1854 Cythere longispina Bosquet:86,pl.6,figs.7a-d

1941 Monoceratina longispina (Bosquet);Bonnema:40,pl.6,figs.69-76

1964c Monoceratina cf.longispina (Bosquet);Kaye:53,pl.3,fig.1

1965c Monoceratina longispina (Bosquet);Kaye:242,pl.1,figs.3,4

(non figs.5-7)

Diagnosis: A smooth species of Monoceratina with an elongated alae.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 444 | L.V. Female | 0.71m.m. | 0.38   | 0.24  |

Description: This smooth species is moderately inflated and the lateral surface is drawn out into an elongate, laterally directed, spine. The ventral margin is weakly concave, almost straight; it is parallel to the dorsal margin; anterior margin broadly rounded with an antero-dorsal cardinal angle. The postero-ventral margin is elongate and gently curved meeting the caudal process postero-dorsally. The laterally directed spine-like alae is situated postero-ventrally to a shallow groove which separates the anterior and posterior portions of the ventral surface.

Remarks: This species has been thoroughly reviewed by Kaye (1965c). He remarked that the original description was from the Senonian. Kaye recorded it from the Middle and Upper Albian and Weaver (MS.) recorded it rarely throughout the Cenomanian of southern England. In the present study it was only recorded sporadically from the E.loricatus and M.inflatum Zones.

Stratigraphic conclusion: This species appears to range through much of the Upper Cretaceous. It first occurs in the D.niobe Subzone of southern England. It is of limited stratigraphic importance mainly due to its rarity.

Monoceratina umbonata (Williamson, 1847)

(pl.33,figs.9,13,14)

1847 Cytherina umbonata Williamson:82,pl.4,fig.78

1849 Cythere umbonata (Williamson);Jones:12,pl.2,figs.3a-e

1890 Cytheropteron umbonatum (Williamson);Jones & Hinde:40,pl.1,figs.

21-24

1893 Cytheropteron umbonatum (Williamson);Chapman & Sherborn:347

1941 Monoceratina umbonata (Williamson);Bonnema:29,pl.6,figs.54-62

1964b Monoceratina umbonata (Williamson);Gründel:857,pl.2,figs.8-10

1964c Monoceratina umbonata (Williamson);Kaye:56,pl.4,figs.3,4,8-10

- 1966 Monoceratina umbonata (Williamson); Gründel: 48, pl. 8, figs. 29-31
- 1978 Monoceratina umbonata (Williamson); Van der Wiel: pl. 2, fig. 8
- 1978 Bythoceratina (Bythoceratina) umbonata (Williamson); Neale:  
pl. 13, figs. 13-14; pl. 14, fig. 1

**Diagnosis:** A species of Monoceratina with a reticulate surface, parallel dorsal and ventral margins, and a small median sulcus.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 445 | L.V. Female | 0.75m.m. | 0.37   | 0.33  |
| 446 | R.V. Female | 0.73     | 0.34   | 0.32  |
| 447 | C. Female   | 0.60     |        | 0.36  |

**Description:** An inflated species with long, straight and parallel, dorsal and ventral margins. The lateral surface is finely reticulate and may be partially smooth or covered in fine spines. The median sulcus is shallow; dorsally to this a small circular inflation is present. A stout spine extends from the postero-lateral surface, this is tilted slightly towards the postero-ventral margin. The anterior margin is broadly rounded with a distinct antero-dorsal cardinal angle; in the right valve the antero-dorsal margin may be obliquely truncated with marginal denticulation antero-ventrally. The posterior margin is sub-triangular and extends to the caudal process which is situated postero-dorsally.

**Remarks:** This species was first described from the 'chalk detritus' of Charing (Cenomanian). Kaye (1964c) stated that most of Jones' figured specimens are pre-adults and that the larger adult forms are rare. This is incorrect as many of the juveniles are much less strongly calcified than the adult forms and are not common due to their poor preservation potential. Most of the figured specimens of Jones are adult specimens. Jones (1849) figures a-e are regarded as typical of this species. The figures f and g are strongly



calcified and show a well developed hinge and weakly developed inner lamellae anteriorally; these are, therefore, adults of other species.

This species is the commonest of this genus in the Albian of southern England. It first appears in the D.niobe Subzone. Weaver (MS.) recorded it ranging throughout the Cenomanian of southern England but less commonly from the Lower Cenomanian.

Stratigraphic conclusion: This species occurs rarely in the Albian and Cenomanian of southern England and Germany. In southern England it first occurs in the D.niobe Subzone. It is of limited stratigraphic significance.

Monoceratina? sp. A. sp. nov.

(pl.33, figs.11,12)

1965c Monoceratina longispina (Bosquet); Kaye: 242, pl.1, figs.5,6

(non figs. 3,4,7)

Diagnosis: A species of Monoceratina? which bears two inflated lobes ventro-laterally, a prominent median sulcus; the lateral surface is covered by a strong reticulation.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 448 | R.V. Female | 0.67m.m. | 0.34   | 0.23  |

Description: This species has a broadly curved anterior margin, slightly curved dorsal, sharply rounded postero-dorsal, broadly rounded postero-ventral and straight ventral margins. The posterior, ventral and anterior marginal areas are flattened. Lateral surface strongly inflated with a large, round median sulcus. Lateral inflation notched at mid-point of dorsal margin. Marginal areas smooth, lateral inflation pitted, pits arranged concentrically around median sulcus.

Remarks: This species was figured by Kaye (1965c) as a juvenile

specimen of M.longispina. He recorded it from the H.orbignyi Subzone of Wrotham, Kent. This species is more strongly calcified and larger than adults of M.longispina. It also exhibits adult internal features.

Stratigraphic conclusion: Only one specimen was recorded from the M.inflatum Zone of southern England. It is of limited stratigraphic significance.

Subfamily UNCERTAIN

Genus Saidia Hornibrook, 1952

Type species: Saidia truncata Hornibrook, 1952

Saidia nettgauensis Gründel, 1966

(pl.31,figs.2,3)

1966 Saidia nettgauensis Gründel:49,pl.8,figs.36,37

Diagnosis: A small, strongly reticulate, species of Saidia with a short postero-ventrally directed lateral extension.

|     |             | Length   | Height | Width |
|-----|-------------|----------|--------|-------|
| 452 | R.V. Female | 0.35m.m. | 0.20   | 0.12  |
| 453 | L.V. Female | 0.35     | 0.20   | 0.12  |

Description: A small, sub-ovate species. The dorsal margin is slightly concave at mid-length and has no cardinal angles. The ventral margin is straight, sinuous, and parallel to the dorsal margin; anterior margin broadly rounded, more sharply so near the ventral margin. The anterior extremity is at two-thirds height; posterior margin more sharply rounded than anterior; posterior extremity at one third height. The lateral surface is weakly inflated and is extended to form a short postero-laterally directed alae which has a sharp ventral edge. A short rib is inset from the dorsal margin which is parallel to it. The ventral surface in dorsal view is weakly concave. The short alae does not obscure the ventral margin and the

lateral surface is strongly reticulate. The anterior margin bears weak denticulation.

Remarks: This distinctive species was first described by Gründel (1966) from the Middle and Upper Albian of Germany. Weaver (MS.) recorded a similar form in the Cenomanian of southern England. In the present study this species was first recorded in southern England in the C.auritus Subzone but occurs more commonly in the S.dispar Zone.

Stratigraphic conclusion: This species first occurs in the Middle Albian of Germany. In southern England it was first recorded in the C.auritus Subzone. It ranges through to the end of the Cenomanian and is of moderate, local, stratigraphic significance.

Gen.A. sp. nov.

(pl.28, figs.14,16,17)

Diagnosis: A sub-ovate species which is poorly inflated with a compressed valve margin.

|     |                  | Length   | Height | Width |
|-----|------------------|----------|--------|-------|
| 466 | Dorsal Female C. | 0.37m.m. |        | 0.16  |
| 467 | L.V. Female      | 0.40     | 0.23   | 0.09  |
| 468 | L.V. Male        | 0.40     | 0.21   |       |

Description: A small, laterally compressed species; dorsal margin broadly rounded; anterior margin rounded; ventral surface weakly arched; posterior margin truncated; postero-dorsal margin straight with a weak cardinal angle. Valve weakly inflated with a laterally compressed marginal rim which extends from the antero-ventral margin along the anterior, dorsal and posterior margins to the postero-ventral margin. Lateral surface smooth with well developed pits. A weak, low, eye tubercle is present inset from the antero-dorsal margin. Males more elongate and less high than females.

They have a weakly concave postero-dorsal margin and a bluntly rounded posterior margin.

Remarks: This species is characteristic of the Upper Albian of southern England. It has not previously been recorded.

Stratigraphic conclusion: This species occurs fairly commonly in the Upper Albian of southern England where it is a moderately important stratigraphic indicator. It first appears in the D. cristatum Subzone and ranges through to the late S. dispar Zone. It has not been recorded from the Cenomanian.